External Vulnerability and Preventive Policies

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External Vulnerability and Preventive Policies: An Overview

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Emerging market economies endure significantly more macroeconomic volatility than industrial countries. Output volatility in emerging market economies is more than twice as large as that in industrial economies, and consumption volatility is three times as large.[1] Recent studies corroborate the view that external factors, such as terms-of-trade and world interest rate shocks, play an important role in explaining these differences. For example, Kose (2002) reports that world price shocks—which include both terms-of-trade and world real interest rate shocks—account for almost 90 percent of output variation in small open economies. Blankenau, Kose, and Yi (2001) and Neumeyer and Perri (2004) find that interest rate shocks account for 30–55 percent of output fluctuations in emerging market economies.

The significant correlation between these external factors and domestic macroeconomic volatility is highly suggestive of their key role, but it does not explain the mechanism through which they operate. In fact, Caballero (2001) documents that while the Chilean business cycle is intimately connected to fluctuations in the price of

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1. These figures correspond to the standard deviation of growth rates of GDP and consumption for industrial and emerging market economies in the 1990s; they are taken from Prasad and others (2003).

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copper (the country's main export good), the economy clearly overreacts to such fluctuations. Domestic consumption losses in the face of a sharp decline in the copper price is many times larger than what one should observe in a frictionless environment. This type of evidence hints at the presence of strong multiplier effects, of which financial mechanisms are leading candidates.

Many recent articles along these lines follow the work of Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), in arguing that external shocks are leveraged by a financial accelerator.[2] In these models, a negative terms-of-trade or interest rate shock not only has a direct effect on the country, but also reduces its net worth. The drop in net worth tightens a collateral constraint, which exacerbates the impact of the external shock. This "collateral squeeze" mechanism is likely to be an important factor in financial amplification, but is probably not the only one.[3] Returning to the case of Chile discussed above, a decline in the copper price, by itself, is unlikely to reduce Chile's net worth enough to justify the size of the contractions associated with sharp declines in the price of copper. This has led several authors to explore credit crunches, in which not only does net worth decline with external shocks, but specialist investors pull out resources beyond what the pure net worth decline justifies. [4] On the empirical front, many papers document the role of the supply side, through contagion and other mechanisms. One of the most recent and compelling is Broner, Lorenzoni, and Schmukler (2005). They construct an extensive database of sovereign bond prices and issuances, which they use to demonstrate that the contractionary behavior of bondholders is central to the rise of interest rate premiums, especially at long maturities.

The fact that external shocks play a primary role does not liberate emerging market economies from responsibility. For example, the presence of extensive liability dollarization reinforces financial multipliers and overwhelms the traditional stabilization role of exchange rate depreciations. When financially constrained firms

2. See, for example, Céspedes, Chang, and Velasco (2003, 2004); Gertler, Gilchrist, and Natalucci (2003); Cook (2004); Devereux and Lane (2003); Christiano, Gust, and Roldós (2004); Cavallo and others (2005); Mendoza and Smith (2002); Choi and Cook (2004).

3. See Holmstrom and Tirole (1997) for a model that distinguishes collateral squeezes from credit crunches.

4. See, for example, Calvo (1999a); Caballero and Krishnamurthy (2001); Broner, Lorenzoni, and Schmukler (2005).

borrow in foreign currency while generating their income in local currency, depreciations of the real exchange rate have a destabilizing effect on aggregate demand. As originally stressed by Calvo (1999b, 2001) and formalized by Céspedes, Chang, and Velasco (2003, 2004), the contractionary effect may overcome the competitiveness channel. In this case, the exchange rate is no longer a stabilization tool, and the advantage of a flexible over a fixed exchange rate regime when dealing with real shocks disappears. The contractionary effect operates because firms decide not to hedge the exchange rate risk. Systemic bailout guarantees may be an important element for understanding such behavior, as argued by Burnside, Eichenbaum, and Rebelo (2001) and Schneider and Tornell (2004).

A question that often arises in these moral hazard models is who the ultimate guarantor is. If the local government has the resources to fulfill this function, then it may not be much of an issue after all. However, the problem of underinsurance may be more pervasive in emerging market economies and it may emerge even in the absence of explicit or implicit guarantees. For example, Caballero and Krishnamurthy (2003) demonstrate that when financial constraints affect borrowing and lending among domestic agents, agents will not hedge their positions to the socially optimal level, creating an aggregate underinsurance problem. The reason is a pecuniary externality, whereby domestic financial frictions depress the expected rewards of hoarding dollars for crises. That is, on one hand the possibility of external shocks raises the expected return on hoarding dollars and reducing dollar liabilities. On the other, limited domestic intermediation lowers ex-post “arbitrage” opportunities and hence offset some of the private (but not the social) expected gains from reduced exposure to depreciations.

Another source of domestic vulnerability is the maturity structure of external liabilities. If an important mismatch develops between a country’s short-term obligations denominated in foreign currency and the actual amount of foreign currency to which that country has access on short notice, then a Diamond-Dybvig run can ensue, as illustrated by Goldfajn and Valdés (1997) and Chang and Velasco (2001). Fears regarding the country’s solvency give rise to liquidity problems as capital inflows fall. Bankruptcies and asset price collapses follow, validating the initial run.[5] Here, too, the

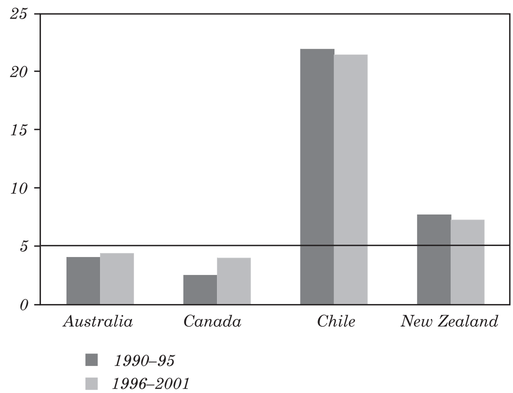
5. See also Aghion, Bacchetta, and Banerjee (2000); Krugman (1999).

question is why agents do not take these risks into account and protect themselves by lengthening the maturity structure. One part of the answer is outlined by Broner, Lorenzoni, and Schmukler (2005), who demonstrate that specialist investors are reluctant to provide long-maturity financing to emerging market economies, especially during episodes of turmoil. Another part of the answer may involve domestic undervaluation of the risks associated with the maturity mismatch. Caballero and Krishnamurthy (2001) develop a model in which domestic and international collateral constraints interact. A tightening of the international constraint can generate a large rise in domestic interest rates and a fire sale of domestic assets, which cause a contraction in real activity. If banks play a crucial role in reallocating resources across sectors and if they are affected by the fall in asset prices, then the initial tightening in the international financial constraint leads to a contraction in effective domestic collateral, which contracts output even further. However, domestic agents may take excessive maturity risk by undervaluing the social cost of such actions, for reasons of domestic financial underdevelopment akin to those mentioned above in the context of liability denomination.

Well managed emerging market economies are able to limit the extent of underinsurance through regulatory and centralized precautionary measures. The significant losses associated with sudden stops have led prudent emerging market economies to pay enormous costs in order to avoid such crises. Figure 1 shows the ratio of international reserves to gross domestic product (GDP) held by Chile—a prudent small open emerging market economy—versus that of several small open developed economies. The message is clear: Chile holds more than four times the reserves of its developed counterparts. The cost of this practice in terms of postponed consumption is large, as by its very nature an emerging market economy should be anticipating rather than postponing consumption.

Large reserve holding is just one of the many costs associated with prudential mechanisms aimed at reducing the impact of capital flow volatility. It is not uncommon, for example, for economists to advocate constraints on short-term borrowing, either in the form of a tax on short-term capital inflows à la Chile in the 1990s (for example, Eichengreen, Tobin, and Wyplosz, 1995) or the accumulation of sufficient reserves to fully offset any existing short-term debt (for example, Greenspan, 1999; Guidotti, 1999; Feldstein, 1999). This advice is costly as well, at least for nondefaulting prudent

Figure 1. Ratio of International Reserves to GDP for Selected Countries



Source: World Development Indicators (online).
a. The horizontal line is the average of Australia, Canada, and New Zealand.

economies, given the significant spreads between short- and long-term borrowing faced by most emerging market economies. Yet another cost paid by prudent economies takes the form of severe precautionary contractions at the first sight of a significant risk of a sudden stop in capital flows, as illustrated by Caballero and Panageas (2003) for the case of Chile during the Russian/long-term capital management (LTCM) crisis.

1. Summary of the Volume

Given the large costs associated with these precautionary mechanisms, the question arises as to whether emerging market economies can do better. This is the organizing theme of this volume, which consists of three parts: characterization of external shocks, current policy responses, and new mechanisms to reduce vulnerability.

Part I of this volume, on the characterization of external shocks, is composed of three papers. Fernando Broner and Roberto Rigobon document the excess volatility of capital flows to emerging markets vis-à-vis capital flows to developed economies. They show that no matter how many controls for demand and supply factors one includes in a variety of regressions, the residual volatility in emerging market economies is about twice as large as that in developed.

César Calderón, Norman Loayza, and Klaus Schmidt-Hebbel conduct a comprehensive cross-country panel study of the response of growth to trade openness, financial openness, and external shocks, as well as to the interaction between these sets of factors. They find that upper-middle-income countries benefit the most from both forms of openness, as their average rate of growth rises significantly. They also find that trade openness tends to dampen the growth effect of trade-related shocks while amplifying the shocks related to financial markets. Interestingly, financial openness tends to have the opposite effect.

Helmut Franken, Guillermo Le Fort, and Eric Parrado study the determinants of the Chilean business cycle since the 1950s using vector autoregressive methods. Their clearest conclusion, given the natural identification through block exogeneity of these shocks, is that real and financial external shocks have played a dominant role throughout. They also tentatively conclude that the Chilean economy has become more resilient to external shocks, despite the increased synchronization with global cycles brought about by deeper integration in world markets. Finally, they provide preliminary evidence for their conjecture that the extra resilience is due to better countercyclical policy management.

Part II, on current policy responses, contains five articles. It starts with the paper by Luis Felipe Céspedes, Ilan Goldfajn, Phil Lowe, and Rodrigo Valdés, which draws common lessons from the recent experiences of Australia, Brazil, and Chile. These economies are subject to fairly similar shocks, but they are at different stages of macroeconomic and institutional development. The main lessons come in the form of a menu whose options are determined and constrained by these stages of development. The actual set of potential policies—in particular, the possibility of implementing countercyclical policies—depends on the health of initial macroeconomic conditions, such as the stock of public debt, the current account deficit, the extent of pass-through, and the level of inflation. It also depends on the level of institutional development, such as the degree of openness, fiscal responsibility, and financial depth, on whether there is a policy framework in place, and on the balance sheet exposures of the private and public sector. To enjoy sufficient flexibility in trying times, the authorities' actions during these times must not be perceived as deviations from a stable and credible medium-term framework. This requires an effort to build credibility in good times and to ensure transparency with respect to any exceptional action.

Pablo García and Claudio Soto evaluate the recent trend among emerging market economies, especially in Asia, to accumulate large amounts of international reserves. They build a simple model of self-fulfilling crises, in which reserve accumulation reduces the chance of the country experiencing a run (that is, a sudden stop of capital inflows). They estimate the probability of a crisis as a function of several determinants, ranging from liquidity to institutional variables, using annual data for eighty countries since 1975. Limited liquidity, measured as a low ratio of reserves to short-term debt, a real exchange rate overvaluation, and low growth are all factors that exacerbate the risk of a crisis. Interestingly, they feed this hazard function into their model and conclude that the large levels of reserve accumulation are commensurate with the benefits they bring in reducing the chance of costly sudden stops. In fact, they argue that it would not be unreasonable for emerging market economies to build war chests of reserves that exceed their current levels.

Kevin Cowan, Erwin Hansen, and Luis Óscar Herrera conduct a detailed analysis of the degree and patterns of currency exposure in Chilean nonfinancial corporations over the last decade. They build a unique dataset in which they supplement accounting data for approximately 150 nonfinancial firms over the period 1995–2003 (taken from the *Ficha Estadística Codificada Uniforme,* or FECUs) with information on dollar debt and assets, exports, derivatives, and ownership. Their conclusions are stark: in Chile, firms with higher dollar debt do not underperform (underinvest) in periods following a depreciation of the exchange rate. The main reason for this is not that balance sheet effects are absent, but that Chilean firms are matched. High dollar debt comes in combination with high dollar assets, currency derivatives, and export orientation of the firm. Matching holds particularly for firms that are likely to be financially constrained and for the period of flexible exchange rates.

Esteban Jadresic and Jorge Selaive explore the effectiveness of a foreign exchange derivatives market in reducing currency risk. Their main focus is on Chile, in particular the recent floating exchange rate period, but they also conduct a series of tests using both high frequency time series for Chile and lower frequency cross-country panels. They offer suggestive preliminary evidence supporting the view that developing the foreign exchange derivatives markets reduces microeconomic and macroeconomic currency risk.

Finally, Sebastián Edwards reviews the arguments for and against capital controls and provides new evidence of their ineffectiveness in reducing external vulnerability. After estimating a hazard model of capital and current account reversals, he concludes that restrictions on capital mobility do not have a significant effect on the probability that a country will experience a reversal. If anything, there is some weak evidence—subject to difficult-to-resolve identification issues—suggesting that countries with greater restrictions have a higher probability of reversal.

Part III, on new mechanisms to reduce volatility, contains three articles. The first is by Kenneth Kletzer who synthesizes recent developments in the sovereign debt literature and draws out the optimal features of contingent liabilities and financial instruments. Sovereign immunity limits the amount of international risk sharing that is feasible. However, some amount of debt renegotiation is not inconsistent with good incentives and is generally welfare enhancing if it can occur in a costless fashion. Similar results can be obtained with GDP- and commodity-indexed bonds. By the same token, optimal implicit contracts with contingent interest payments can be implemented through interest rate swap markets. The specific form of information asymmetries is important in determining the optimal stripping of the countries' contingent liabilities. More generally, financial market innovation should be aimed at reducing renegotiation costs and deepening international capital markets by increasing risk sharing, while respecting self-enforcement constraints.

Francisco Gallego and Geraint Jones revisit fear of floating from an optimal policy perspective. Is constrained flexibility an optimal response to noisy financial shocks? Or does it simply reflect a time-consistent but suboptimal policy? The benefit of constrained flexibility is based on the need to build inflation credibility and protect dollarized balance sheets, as in Calvo and Reinhart (2002). The benefit of exchange rate flexibility, in turn, is based on the need to provide the private sector with the right incentives to insure against crises; since this is an ex ante mechanism, however, ex post the central bank has an incentive to renege, as in Caballero and Krishnamurthy (2005). The authors conclude that a compromise could be struck by using noncrisis periods to stabilize the exchange rate and crisis periods to provide insurance incentives (that is, let the exchange rate float freely). Nevertheless, countries that are at early stages of free-floating may not enjoy the luxury of this state-contingent policy and may have to free-float at all times. In the empirical part of their paper, they reexamine the fear-of-floating findings from this refined perspective, and they find support for their predictions. In particular, among the free-floaters, those that have established the credibility of their regime are able to use optimal state-contingent policies, employing a free-float more actively during sudden stop episodes.

Finally, Ricardo Caballero and Stavros Panageas argue that while the possibility of sudden stops indeed raises the need to accumulate reserves, it does not support the current practice of holding reserves in the form of noncontingent foreign bonds and deposits. They first develop a simple portfolio model in which sudden stops correspond to shocks that raise the marginal value of a dollar of reserves. Not surprisingly, the optimal portfolio of reserves should include assets that, on average, yield high returns during sudden stops, which is not the case with the conventional instruments held by central banks (U.S. Treasury bonds yield more or less the same return in all states of nature). They go on to estimate the key parameters of the model using data for several emerging market economies in the 1990s, and they find globally traded instruments that satisfy the above condition. For example, they show that, historically, the VIX (implicit volatility index extracted from the price of derivatives on a few S&P500 firms) has jumped in almost every episode of systemic emerging market sudden stops. Optimally adding call options on the VIX to reserves would increase the stock of reserves, on average, by 30 percent during sudden stops. Concretely, the Central Bank of Chile would have made a capital gain of approximately US$6 billion during the sudden stop following the Russian/LTCM crisis. This amounts to more dollars than its entire intervention during that trying period, and it exceeds the current account reversal experienced by Chile.

2. Taking Stock

Several policy lessons emerge from the papers presented in this volume. From a medium- to long-term perspective, Calderón, Loayza, and Schmidt-Hebbel find that policies promoting increased integration with international goods and capital markets may help sustain higher growth rates and dampen the negative effects of external shocks. Financial integration helps dampen the volatility effects of adverse financial shocks, while trade integration may dampen the impact of trade-related shocks. Broner and Rigobon's work suggests that some of these conclusions are also likely to carry on to higher frequency as capital flow volatility is reduced by improved financial markets and institutions.

From a short- to medium-term perspective, Céspedes, Goldfajn, Lowe, and Valdés describe the ideal policy framework for dealing with external shocks, based on the experiences of Australia, Brazil, and Chile. This policy arrangement includes a floating exchange rate regime, a credible medium-term inflation-targeting regime, a sustainable and credible fiscal policy, and liquid and well-developed financial markets. Perhaps most importantly, they argue convincingly—as does Woodford (2003)—that a key aspect of success with discretionary policy in exceptional times is to have a transparent and credible policy framework in place.

Jadresic and Selaive suggest that flexible exchange rates—as a tool to reduce emerging market economies' vulnerability to external shocks—are more effective in the presence of a well-developed foreign exchange derivatives market, which reduces aggregate currency risk. Cowan, Hansen, and Herrera demonstrate that floating exchange rates and derivatives have helped Chilean firms to reduce currency exposure since 1999. Finally, Gallego and Jones suggest the application of state-contingent flexibility in exchange rate policies to deal with issues such as sudden stops and fear of floating.

As for less standard mechanisms, Kletzer proposes the introduction of contract innovations in international debt renegotiation to reduce the volatility of external debt. Specifically, he recommends the development of derivatives contracts to implement risk sharing and eliminate bond renegotiation. These derivative contracts may allow debtors to reduce default and restructuring risk for bondholders. Caballero and Panageas similarly propose better risk management practices for central banks. They suggest that portfolios encompassing (riskier) assets that are correlated with sudden stops are superior to a simple strategy of reserve accumulation. As an illustration, they find that the cost of facing sudden stops would be substantially reduced if a central bank held contracts on the S&P implied volatility index.

In conclusion, emerging market economies face substantial real and financial volatility. While a significant component of this volatility is exogenous to them, it does not mean that domestic policy is of secondary importance. Quite the opposite: facing large volatility makes good domestic policy decisions all the more important. This volume is an attempt to characterize the main external shocks affecting emerging market economies, the sources of structural weaknesses, and the best policy frameworks for dealing with these problems. Some of the policy lessons come from reasonably well-traveled roads, as they are derived from actual experiences documented through case and panel studies. Yet others are derived from normative analysis, and only hint at the elements that future policies ought to have. We tried to strike a balance and achieve some continuity between both, as our goal was not only to document but also to move forward a policy agenda that puts the concept of country insurance at the heart of policy design.

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Why Are Capital Flows So Much More Volatile in Emerging Than in Developed Countries?

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One of the most studied subjects in open macroeconomics is what determines capital flows. In general, most papers are concerned with estimating the following regression:

$$K_{i,t} = c_i + X_{i,t}A + \varepsilon_{i,t} ,$$

where the left-hand side is some measurement of capital flows, either as a percentage of gross domestic product (GDP) or as changes, and the right-hand side introduces several time and cross-sectional controls, such as GDP growth, real exchange rates, the international interest rate, terms of trade, availability of international funds, or some measure of credit constraints. Almost the entire literature focuses on the properties of A, such as the signs and significance of the coefficients and the most important determinants. This paper takes a different perspective: we concentrate on the explanatory power of fundamentals and on the properties of the residuals—that is, the portion of capital flows that is unexplained by fundamentals.

This new dimension allows us to uncover a pattern that has escaped the literature: the fundamentals have some explanatory power for capital flows (the R squared values of the regressions are not zero), but this explanatory power is quite small, especially considering that we are

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probably overestimating the explanatory power of these variables owing to problems of endogeneity and omitted variables. Furthermore, the ratio of standard deviations between the residuals for emerging countries and the residuals for developed countries is very stable to different measures of capital flows, controls for domestic and external shocks, and nonlinearities and asymmetries. We find that capital flows to emerging countries are 80 percent more volatile than those to developed economies; this ratio falls to 62 percent when we control for a series of macroeconomic variables. In contrast, we find that nonfundamental variables, such as outliers, lags, and contagion effects, reduce this ratio to 16 percent.[1]

The paper is organized as follows. The first section reports the difference in volatility of capital flows to emerging versus developed countries. The second section then outlines the effect of controlling for macroeconomic variables, while the third identifies some statistical regularities of the residuals. The fourth section studies the determinants of the unconditional volatility. The final section concludes.

1. Volatility in Emerging and Developed Countries

This section documents the excess volatility in capital flows to emerging countries, to then explore its determinants in the rest of the paper. We collected data on total capital flows measured as the capital account in the balance-of-payment statistics, GDP, inflation, exchange rate, nominal interest rates, and the terms of trade, yearly for the period 1965–2003 from the International Monetary Fund's *International Financial Statistics* (IFS). The data set includes twenty-three industrialized countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States), seven Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico, Uruguay, and Venezuela), nine Asian countries (China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, and Thailand), thirteen transition countries (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovak Republic, Slovenia, and Ukraine), and six other

1. Hausmann, Panizza, and Rigobon (2004) find very similar patterns in real exchange rate volatilities. The stylized facts in this paper are not of the same nature, however, because the high volatility of the capital flows remained when we controlled for exchange rate movements.

countries (Egypt, Morocco, Nigeria, South Africa, Tunisia, and Turkey).[2] These countries are divided in two broad groups: developed and emerging countries. For the analysis of common components, the emerging countries are also divided into Latin America, Asia, transition countries, and other, since we test for contagion effects within these groups.

We also collected information on real income per capita from the Penn World Table; on financial development (ratios of private domestic credit and liquid liabilities over GDP) from Loayza, Fajnzylber, and Calderón (2005); and on the quality of institutions from the International Country Risk Guide.[3]

Figure 1 shows the standard deviation of capital flows as a percentage of GDP, calculated country by country. The countries have been sorted from the smallest standard deviation to the highest. As can be easily seen, the countries located on the left-hand side of the figure are mostly developed countries, while the emerging countries are concentrated on the right-hand side. Table 1 shows the standard deviation of capital flows for each of the two groups. Capital flows as a percentage of GDP in emerging countries are 80 percent more volatile than in developed countries. In addition, capital flows to both groups are left skewed, but they are substantially more so for emerging countries.

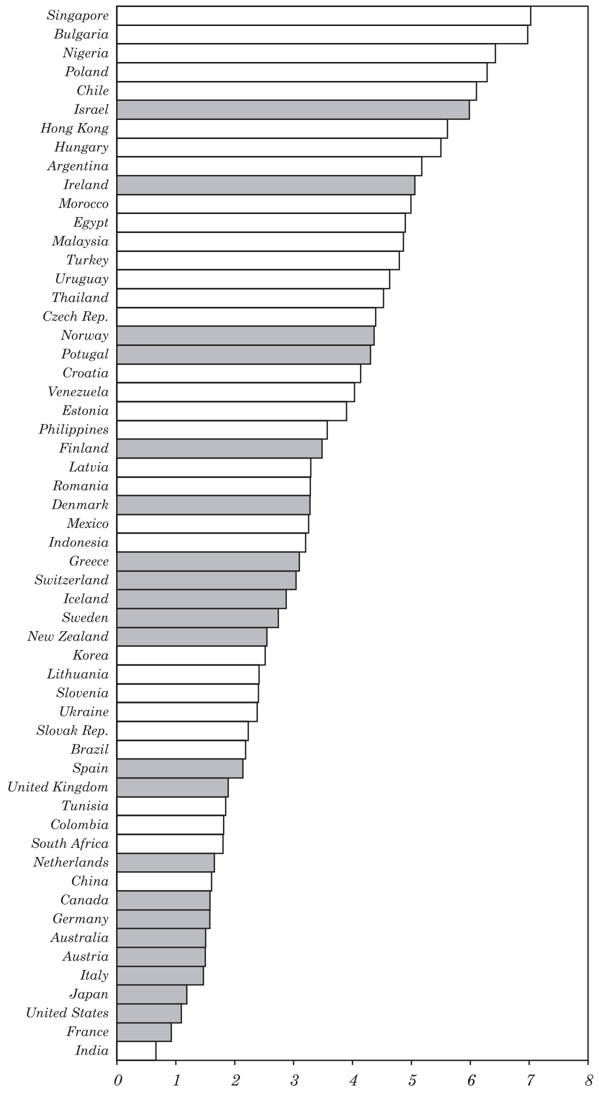
There are at least three possible explanations for this pattern. First, emerging countries might be hit by fundamental shocks that have different stochastic properties than those that affect developed countries, and the capital flows might just reflect those properties. Second, capital flows to emerging and developed countries might respond differently to similar fundamental shocks. Third, emerging countries might be subject to larger sources of nonfundamental shocks, such as crises, persistence, and contagion.

With respect to the first explanation, emerging countries could be, on average, subject to larger and more left-skewed fundamental shocks. Indeed, emerging countries experience larger, more skewed shocks, on average, in terms of inflation, interest rates, real exchange rates, output, and terms of trade. In this case, the difference in the characteristics of capital flows should be reflected in differences in

2. The twenty-three industrialized economies are the members of the Organization for Economic Cooperation and Development (OECD) plus Israel and minus Mexico and Korea. The results are not sensitive to this choice.

3. We thank Norman Loayza for providing us with the data on financial development and institutional quality.

Figure 1. Standard Deviation of Capital Flows[a]



Source: Authors' calculations.

a. The gray bars indicate developed countries; the clear bars emerging countries.

Table 1. Statistics on Capital Flows for Emerging and Developed Countries

Group	*Standard deviation*	*Skewness*
Developed countries	3.175	–0.502
Emerging countries	5.677	–0.760
Ratio	1.790	1.520

Source: Authors' calculations.

the behavior of fundamentals. We study this possibility below, including the role of nonlinearities and asymmetries in explaining the higher volatility of capital flows.

With respect to the second explanation, emerging countries might respond more strongly than developed countries to similar fundamental shocks. If so, the two groups of countries would differ in the sensitivity of capital flows to fundamentals. For example, a large literature studies the amplification of shocks when financial markets are less developed; this amplification means that capital flows would be more volatile in emerging versus developed countries in response to the same shock.

Finally, other, nonfundamental shocks could explain the difference in volatility. This would generate differences in the behavior of the portion of capital flows that is unexplained by fundamental shocks (that is, residuals). We analyze a number of possibilities: crises (left-skewed residuals), contagion (correlated residuals), and persistence of shocks (lags).

This paper provides two complementary types of evidence. First, we examine which factors account for the standard deviation of capital flows in emerging and developed countries (panel regressions). The purpose of this exercise is to decompose the ratio of the standard deviations to determine the relative weight of the explanations mentioned above. These are not variance decompositions because the regressors are not orthogonal, but the decomposition is still informative. Second, we identify characteristics of emerging countries that lead to higher volatility of capital flows (cross-sectional volatility regressions).

Our interpretation of the excess volatility of emerging countries is that it involves a specification problem, and the higher standard deviation reflects omitted variables. This is almost a tautological interpretation, but it guides us in the empirical strategy we pursue in the following sections. We introduce the variables one at a time and test each theory in turn, trying to reduce the excess volatility of residuals from 80 percent to close to zero.

2. Volatility and Fundamentals

Many fundamental variables can have an effect on capital flows, including terms-of-trade shocks, productivity shocks, time preference shocks, and initial endowments. Although it is impossible to construct a large panel that includes emerging countries with all relevant fundamentals, those fundamentals are likely to be reflected in macroeconomic variables (for example, productivity shocks in GDP and time preference shocks in interest rates). We consider GDP, inflation, the interest rate, the exchange rate, and the terms of trade. If we tried to identify causation, we would face problems of endogeneity and omitted variables. Our objective, however, is not to resolve the problem of identification, but rather to determine the extent to which fundamental variables might be responsible for the volatility of capital flows. We find that these variables explain very little of the volatility of capital flows. The possible existence of reverse causation and omitted variables thus suggests that in reality fundamental shocks account for even less of the volatility of capital flows than implied by our low R squared values.

We estimate panel regressions of the following form:

$$K_{i,t} = c_i + X_{i,t}A_i + \varepsilon_{i,t} ,$$

where $X_{i,t}$ represents the controls or macroeconomic variables. We restrict the coefficients A_i to be the same within the two groups of countries, since we do not have enough data to estimate country-specific coefficients. However, by allowing the coefficients to differ between emerging and developed countries, we allow for different sensitivities to play a role in explaining the higher volatility of capital flows to emerging countries.

This is a reduced-form representation, so no interpretation of the coefficients A_i should be given. Several of the variables that we include on the right-hand side are clearly endogenous to capital inflows, such as the interest rate and the exchange rate. The estimation of A_i thus suffers from simultaneous equations bias. In this paper, however, we are concerned with the possible explanatory power of the fundamentals and with the properties of the residuals, not with the coefficients per se. By projecting the capital flows onto the endogenous variables, we tend to maximize their explanatory power, reducing the standard deviation of the residuals to a minimum. As a result, the true explanatory power of any set of fundamentals we consider should be between zero and the result we report.

Table 2 reports the results of running the regression for different sets of macroeconomic variables. We included the macroeconomic variables one by one to try to understand their incremental effect on the overall variance, standard deviation, and skewness. The control variables are GDP per capita (in logs), the exchange rate depreciation, the inflation rate, the domestic interest rate, and the terms of trade measured by both import and export prices (in logs).[4] The first row in table 2 is our benchmark, in which we control for fixed effects only.[5] From the second to the sixth rows, we introduce macroeconomic variables into the specification one at a time.[6] For each group of countries (developed and emerging), the first column is the fraction of the variance of the residuals that is explained relative to the specification in which we only have fixed effects (first row).[7] The second column is the standard deviation of the residuals, and the third column is the skewness of the residuals. The last two columns are the ratio of the standard deviation and skewness of residuals for the two groups of countries.

The first result worth highlighting is that fundamentals may explain some of the capital flow volatility that we observe: the R squared rises to 5 percent for developed countries and 20 percent for emerging countries. The second result—the one we focus on here—is that the ratio of the standard deviation of residuals for emerging and developed economies is remarkably stable to the introduction of these fundamentals.

Figure 2 summarizes these results. We show the standard deviations of the residuals as well as the ratio of standard deviations for all the

4. The regressions are balanced, in the sense that we only use observations for which all control variables are available; the number of observations is therefore the same in all specifications. We obtained the same results when we included the GDP growth rate and the growth rate of the terms of trade instead of levels.

5. In principle, to compute the standard deviation of capital flows for the countries in each group, we would not need to include a constant term for each country. However, in this case the standard deviation of the residual would reflect both the time series volatility within each country and the cross-sectional variation across countries. The latter, however, does not usually figure in what is understood as capital flow volatility. Consequently, we always include country fixed effects, and the fixed-effects regression is the benchmark against which we compare all the other regressions.

6. We also estimated specifications including unemployment. We decided to exclude those specifications, however, because including unemployment reduced the sample significantly and did not change the results at all. Results are available on request.

7. This is more informative than R squared since, given our focus on volatility, we are not interested in the fraction of the variance explained by fixed effects.

Table 2. Statistics on Capital Flows: Domestic Macroeconomic Variables[a]

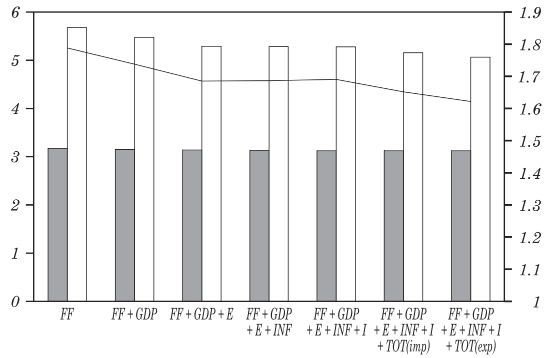
	Developed countries			*Emerging countries*			*Ratio*	
Control variables included in regression	R^2 *(%)*	*Standard deviation*	*Skewness*	R^2 *(%)*	*Standard deviation*	*Skewness*	*Standard deviation*	*Skewness*
FE	0.0	3.175	–0.502	0.0	5.677	–0.760	1.788	1.516
FE + GDP	1.5	3.151	–0.504	7.0	5.476	–0.653	1.738	1.295
FE + GDP + E	2.3	3.138	–0.510	13.2	5.289	–0.658	1.685	1.291
FE + GDP + E + INF	2.6	3.134	–0.499	13.3	5.285	–0.639	1.686	1.28
FE + GDP + E + INF + I	3.2	3.123	–0.513	13.5	5.279	–0.659	1.690	1.286
FE + GDP + E + INF + I + TOT(imp)	3.3	3.122	–0.508	17.5	5.158	–0.682	1.652	1.342
FE + GDP + E + INF + I + TOT(exp)	3.3	3.122	–0.511	20.4	5.064	–0.760	1.622	1.486

Source: Authors' calculations.

a. The macroeconomic control variables are as follows: FE: fixed effects; GDP: per capita GDP (in logs); E: exchange rate depreciation; INF: inflation rate; I: domestic interest rate; TOT(imp): terms of trade measured by import prices (in logs); and TOT(exp): terms of trade measured by export prices (in logs).

specifications. As the figure illustrates, the standard deviation of residuals for emerging countries is reduced by around 10 percent, while the ratio of the standard deviations is reduced from 1.788 to 1.622.

Figure 2. Standard Deviation for Each Group and All Specifications[a]



Source: Authors' calculations.
a. Ratio of standard deviations is measured on the right hand axis. The gray bars indicate developed countries; the clear bars emerging countries.

This exercise demonstrates that even though domestic macroeconomic variables may have some explanatory power for capital flows, they contribute little to explaining the ratio of standard deviations across groups. Moreover, the skewness of the residuals is only slightly affected by the introduction of macroeconomic variables. It is interesting that the skewness associated with exchange rate depreciations is unable to explain the skewness in the data. One of the most obvious reactions to the stylized facts in the previous section is that crises might be an important component for explaining the skewness and volatility of capital flows to emerging countries. However, our results suggest that the skewness and volatility in macroeconomic variables cannot account for these effects. We come back to this point later. In summary, the higher volatility and skewness of capital flows to emerging countries cannot be accounted for by a different behavior of, or different response to, macroeconomic variables.

2.1 External Factors

Apart from domestic factors, capital flows should also depend on international factors, such as international interest rates. In this section, we control for the U.S. real interest rate, constructed as the difference between the U.S. short-run nominal interest rate and U.S. inflation.[8]

The results are summarized in table 3. We run the same specifications as before, where we first introduce the real interest rate in the regression and then add each of the macroeconomic variables in turn. The table only presents the results of the first and last of these regressions. We compare them to the benchmark and to the regression with all the macroeconomic variables.

External factors have very little explanatory power: the *R* squared is only 1 percent for emerging countries and 0.2 percent for developed economies. A comparison of the third and fourth rows further indicates that international interest rate movements are already included in some of the macroeconomic variables that we considered in the previous exercise. Once we account for domestic factors, the U.S. interest rate increases the *R* squared by less than 0.1 percent. This suggests that some of the explanatory power of domestic variables for emerging countries actually reflects the (limited) response to international interest rates.

Including other external factors—such as output and inflation in G7 countries or output, the nominal exchange rate, and inflation of the major trading partners—also has almost no effect on the *R* squared and the relative standard deviations. We included these variables in the specification one at a time, and the U.S. interest rate performed best in terms of *R* squared.

In summary, adding external factors to the regression does not significantly affect the standard deviation of capital flows, either the levels or the ratio between emerging and developed countries. The skewness of residuals is not affected, either.

2.2 Nonlinearities

A third alternative worth exploring is the possibility that capital flows respond to shocks to fundamentals nonlinearly. Such a response may account for both higher volatility and skewness. To explore this possibility, we introduced nonlinear terms in the regression. We introduced each of the macroeconomic variables in the regressions with a quadratic term to test for convexities and with an absolute value to

8. The possibility of contagion may also be considered an external factor, but in the absence of a clear fundamental counterpart, we consider contagion in the next section on statistical properties of capital flows. However, several theories of contagion imply that contagion should be reflected in international interest rates; hence, the introduction of the U.S. short-term interest rate is also controlling for contagion.

Table 3. Statistics on Capital Flows: Domestic and External Macroeconomic Variables[a]

	Developed countries			*Emerging countries*			*Ratio*	
Control variables included in regression	*R^2 (%)*	*Standard deviation*	*Skewness*	*R^2 (%)*	*Standard deviation*	*Skewness*	*Standard deviation*	*Skewness*
FE	0.0	3.175	–0.502	0.0	5.677	–0.760	1.788	1.516
FE + RIUS	0.2	3.172	–0.500	1.0	5.648	–0.752	1.781	1.505
FE + GDP + E + INF + I + TOT(exp)	3.3	3.122	–0.511	20.4	5.064	–0.760	1.622	1.486
FE + RIUS + GDP + E + INF + I + TOT(exp)	3.3	3.122	–0.512	20.4	5.064	–0.759	1.622	1.484

Source: Authors' calculations.

a. The macroeconomic control variables are as follows: FE: fixed effects; RIUS: U.S. real interest rate; GDP: per capita GDP (in logs); E: exchange rate depreciation; INF: inflation rate; I: domestic interest rate; and TOT(exp): terms of trade measured by export prices (in logs).

test for asymmetries. We performed this exercise with each of the macroeconomic variables in each of the specifications. Nonlinearities improved the *R* squared values very little, and they never reduced the ratio of the standard deviations bellow 1.612.[9]

2.3 The Role of Fundamentals: Summary

Once we account for domestic and international macroeconomic variables and nonlinear effects, we are able to explain very little of the volatility of capital flows to emerging markets. In particular, we explain very little of the difference in the standard deviation and skewness of capital flows between emerging and developed countries. We began by stating that capital flows to emerging countries are 78.8 percent more volatile than those to developed economies; this ratio fell to 62.2 percent when we controlled for all these shocks. Moreover, we are probably overestimating the explanatory power of these variables since we are ignoring endogeneity and omitted variables in the specifications.

Since we cannot explain why capital flows to emerging countries are more volatile using fundamentals, in the next section we explore some statistical properties of capital flows to help determine where the answer may lie.

3. Statistical Properties of Volatility: Crises, Persistence, and Contagion

In this section we study the residuals from a different perspective. We assume that a sizeable proportion of the volatility is nonfundamentally driven, and we study three possibilities: the role of outliers (or what we identify as crises), the role of persistence (or lags), and the role of contagion. Notice that all these effects are in addition to the crises, persistence, and contagion that are already reflected in interest rates, exchange rates, inflation, output, and terms of trade.

3.1 Crises

The previous sections showed that capital flows to emerging countries are both more volatile and more left skewed than capital

9. We do not report the results of these regressions because nonlinearities made very little difference. Results are available on request.

flows to developed countries. It seems reasonable that emerging country crises may have a role in accounting for both observations. In this section, we analyze this possibility by looking at the effect of excluding outliers from the residuals of the regressions in the previous section. In particular, we define an outlier as a residual that is more than two standard deviations away from zero, where the standard deviation is calculated country by country. We look at the effect of excluding residuals on the R squared values, the standard deviation of residuals, and skewness. The variance, standard deviation, and skewness are calculated on the residuals that remain after we exclude the outliers.

The results are presented in table 4. We report the results for two specifications: the pure fixed effects (our benchmark) and the fixed effects plus the macroeconomic controls including the U.S. real interest rate. For each specification, we compare the standard deviation of all the residuals to the standard deviation of the residuals that remain after we exclude the outliers.

The elimination of the outliers reduces the standard deviation in both samples significantly. The R squared values are all above 45 percent. The most surprising result is that the ratio of the standard deviations is almost unaffected by this procedure. The ratio of standard deviations only falls from 1.788 to 1.754 and from 1.622 to 1.599, respectively, in the two specifications. This procedure, however, does eliminate the skewness in the data, from an average absolute value of 0.5–0.7 to roughly 0.1 or less.

Although not reported, this procedure also reduces kurtosis, from between 5 and 6 to close to 3. The outliers thus explain the nonnormal behavior of the distribution of residuals, but they do not account for the higher volatility of capital flows to emerging countries. These results are robust to all the previous specifications described so far.

3.2 Persistence

We now examine the possibility that shocks have different persistence in emerging and developed countries. Persistence is not a typical fundamental included in theories on capital flows, which is why we think of persistence as a statistical property of capital flows. We study the issue of persistence by adding lags to two specifications: fixed effects and all macroeconomic controls excluding outliers. We first add the lag of the capital flows alone, and then include the lags of the macroeconomic variables as well.

Table 4. Statistics on Capital Flows: Domestic and External Macroeconomic Variables, Excluding Outliers[a]

	Developed countries			*Emerging countries*			*Ratio*	
Control variables included in regression	R^2 *(%)*	*Standard deviation*	*Skewness*	R^2 *(%)*	*Standard deviation*	*Skewness*	*Standard deviation*	*Skewness*
FE	0.0	3.175	–0.502	0.0	5.677	–0.760	1.788	1.516
FE	0.0	3.175	–0.502	0.0	5.677	–0.760	1.788	1.516
FE + RIUS + GDP + E + INF + I + TOT(exp)	3.3	3.122	–0.512	20.4	5.064	–0.759	1.622	1.484
No outliers + FE	46.9	2.313	0.023	48.9	4.058	–0.144	1.754	N/A
No outliers + FE + RIUS + GDP + E + INF + I + TOT(exp)	48.6	2.276	–0.025	58.9	3.639	0.007	1.599	N/A

Source: Authors' calculations.

a. The macroeconomic control variables are as follows: FE: fixed effects; RIUS: U.S. real interest rate; GDP: per capita GDP (in logs); E: exchange rate depreciation; INF: inflation rate; I: domestic interest rate; and TOT(exp): terms of trade measured by export prices (in logs).

Table 5. Statistics on Capital Flows: Domestic and External Macroeconomic Variables, with Lags[a]

	Developed countries			*Emerging countries*			*Ratio*	
Control variables included in regression	R^2 *(%)*	*Standard deviation*	*Skewness*	R^2 *(%)*	*Standard deviation*	*Skewness*	*Standard deviation*	*Skewness*
FE	0.0	3.175		0.0	5.677		1.788	
No out. + FE + RIUS + GDP + E + INF + I + TOT(exp)	3.3	3.122		20.4	5.064		1.622	
Lag(KF) + FE	24.6	2.757	0.483	41.4	4.346	0.646	1.576	1.336
Lag(KF) + No out. + FE + RIUS + GDP + E + INF + I + TOT(exp)	65.4	1.867	0.475	82.3	2.389	0.607	1.258	1.278
Full lags + No out. + FE + RIUS + GDP + E + INF + I +TOT(exp)	65.0	1.877	0.481	81.6	2.437	0.578	1.298	1.201

Source: Authors' calculations.

a. The macroeconomic control variables are as follows: FE: fixed effects; RIUS: U.S. real interest rate; GDP: per capita GDP (in logs); E: exchange rate depreciation; INF: inflation rate; I: domestic interest rate; TOT(exp): terms of trade measured by export prices (in logs); lag(KF): lag of capital flows only; and full lags: lags of all included macroeconomic variables.

Table 5 summarizes the results.[10] Since the skewness was entirely accounted for by excluding outliers, we no longer report this statistic. Instead, we report the coefficient on the lag of the capital flows. The first row is our benchmark; the second row is our regression with all the macroeconomic variables and excluding outliers. The regression reported in the third row only controls for fixed effects and the lag of capital flows. The fourth row is the specification with the lag, all the macroeconomic variables, and no outliers. The last row also includes the lags of all the right-hand-side variables.

Persistence accounts for a large fraction of capital flow volatility. The R squared of the regression including just the lag of capital flows is 41 percent for emerging countries and 25 percent for developed countries. Once we account for macroeconomic controls and outliers, the R squared increases to 65 percent for developed countries and 82 percent for emerging countries.

Contrary to the effect of excluding outliers, accounting for persistence not only increases the explanatory power of our regressions, but also substantially decreases the ratio of standard deviations. This is reflected in the different coefficients of lag capital flows, which are quite higher for emerging countries than for developed countries; this implies that capital flows are more persistent in emerging than in developed countries. The coefficient on the lag in emerging countries is usually higher than 0.60, while it is below 0.50 for developed countries.

Before, the exclusion of outliers had little effect on the ratio of residuals, but it does have a significant effect on this ratio once we account for different persistence. The combined effect of accounting for persistence and excluding outliers is to reduce the ratio of standard deviations from 1.788 to 1.298.[11]

3.3 Contagion

The last statistical property of capital flows we analyze is the comovement of flows across countries that is not explained by

10. As in the previous sections, we performed the same test for all the possible specifications and here only report the most pertinent.

11. We do not know why the effect of excluding outliers on the ratio of standard deviations is more important once we account for persistence. One possibility is that crises in emerging countries follow periods of high capital inflows more than in the case of developed countries. Accounting for persistence therefore increases the expected inflow right before the crisis in emerging countries more than in developed countries, increasing the relative size of the negative innovation.

macroeconomic variables. We denote this comovement as contagion. We construct a common component of capital flows for different groups of countries and study the extent to which these common components explain capital flows in each group. The groups are Latin America, Asia, Eastern Europe, other emerging countries, and developed countries. We use two methodologies to construct the common component. First, we consider a true common component computed by the first principal component. The problem with this measure is that we do not have a long enough time series, so not all countries can be included to form the principal component. This clearly underestimates the common factor. As a result, the common component in our second methodology is simply the average capital flows for the group in each year. For each methodology, we add the principal component to the right-hand side of our regressions.

The results are summarized in table 6. The third and fifth rows present the results of adding the principal component constructed with the first methodology (PC), while the fourth and sixth rows present the results of adding the principal component constructed with the second methodology (PCAVE). The results of the third and fourth rows clearly suggest that the principal components may explain a substantial fraction of capital flows volatility, especially for emerging countries. However, this depends very much on the methodology used to construct the principal components, and it is not clear which one should be preferred.[12] The results of the fifth and sixth rows, in turn, indicate that the principal components also have some explanatory power when we consider persistence and outliers for the case of emerging countries, although not for the case of developed countries. As a result, the ratio of standard deviations is further reduced to below 1.2.

Capital flows to emerging countries are more correlated than capital flows to developed countries. Consequently, when we add common components to the regressions, we reduce the relative volatility of capital flows to emerging countries. One shortcoming of this exercise is that we cannot determine whether this result is due to contagion or to an unobserved common determinant of capital flows to emerging countries. Regardless of the explanation for the result, we can say that common external conditions must play a significant role in explaining capital

12. If we had a longer time series, we would have more faith in the results of the regressions in which the principal components are constructed in the traditional way; however, such data are not available to us. The main problem is that estimating principal components requires as many time observations as series to be included. This is impossible for the Eastern European countries, for which we have at most ten years of information.

Table 6. Statistics on Capital Flows: Domestic and External Macroeconomic Variables, with Lags and Common Components[a]

	Developed countries			*Emerging countries*			*Ratio*	
Control variables included in regression	R^2 *(%)*	*Standard deviation*	*Lag coeff.*	R^2 *(%)*	*Standard deviation*	*Lag coeff.*	*Standard deviation*	*Lag coeff.*
FE	0.0	3.175		0.0	5.677		1.788	
Lag(KF) + No out. + FE + RIUS + GDP + E + INF + I + TOT(exp)	65.0	1.877	0.481	81.6	2.437	0.578	1.298	1.201
PC + FE + RIUS	2.6	3.132		4.1	5.559		1.775	
PCAVE + FE + RIUS	4.6	3.100		39.0	4.433		1.430	
PC + Lag(KF) + No out. + FE + RIUS + GDP + E + INF + I + TOT(exp)	65.5	1.864	0.491	84.5	2.237	0.586	1.200	1.194
PCAVE + Lag(KF) + No out. + FE + RIUS + GDP + E + INF + I + TOT(exp)	61.8	1.961	0.509	83.9	2.277	0.573	1.161	1.127

Source: Authors' calculations.

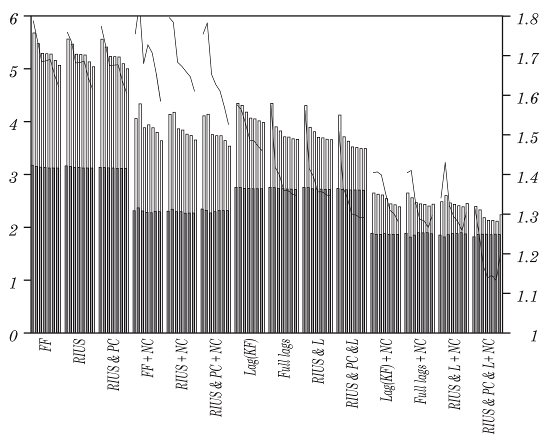
a. The macroeconomic control variables are as follows: FE: fixed effects; RIUS: U.S. real interest rate; GDP: per capita GDP (in logs); E: exchange rate depreciation; INF: inflation rate; I: domestic interest rate; TOT(exp): terms of trade measured by export prices (in logs); lag(KF): lag of capital flows only; PC: true common component computed by the first principal component; and PCAVE: common component constructed as the average capital flows for the group in each year.

flows to emerging countries and that these common external conditions have little to do with international interest rates.

3.4 Summary

Figure 3 shows the ratio of standard deviations of capital flows to emerging countries relative to developed countries for most of the specifications we ran. The x-axis includes all the regressions in which we control for domestic macroeconomic variables, international interest rates, outliers, persistence, and contagion. The bars represent the standard deviation of the residuals (measured on the left vertical axis), and the line shows the ratio of standard deviations (measured on the right vertical axis). A measure of the explanatory power is to compare the size of the bars to the first one on the left, which corresponds to our benchmark.

Figure 3. Standard Deviation for Each Group and All Specification, Excluding Outliers and Including Lags and Common Components[a]



Source: Authors' calculations.
a. Ratio of standard deviations on the right hand axis. The gray bars indicate developed countries; the clear bars, emerging countries.
L: lags. NC: no crisis.

As we argued above, macroeconomic controls and international interest rates have a small effect on the volatility of residuals and almost no effect on the ratio of standard deviations. This is despite the fact that endogeneity and omitted variables suggest that what little they explain is probably an overestimation of the actual effect of these variables.

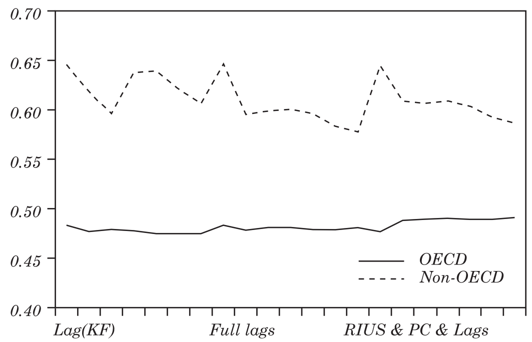
When we examined whether the statistic properties of capital flows can shed light on possible explanations for the volatility of capital flows to emerging countries, we found three properties that account for almost all the excess standard deviation. Capital flows to emerging countries are more frequently affected by crises, are more persistent, and are more correlated with capital flows to similar countries than are capital flows to developed countries. Once we control for these differences, the ratio of standard deviations of residuals drops from 1.788 to 1.161.

The fact that domestic macroeconomic variables cannot account for crises, together with the fact that capital flows to emerging countries are quite correlated, suggests the importance of external, or supply, factors in explaining such flows.[13] Interestingly, international interest rates have very little explanatory power, suggesting that it is not the "representative world consumer" who supplies capital to emerging countries. In other words, the market for capital to emerging countries is probably somewhat segmented, subject to shocks unrelated to domestic macroeconomic conditions, and characterized by contagion. While these conclusions might not be surprising in themselves, we are struck by how much of the excess volatility of capital flows to emerging countries these characteristics can account for, especially considering the negligible effect of domestic macroeconomic variables and world interest rates.

Another important finding is that capital flows to emerging countries are substantially more persistent than those to developed countries. Figure 4 presents the autoregressive coefficient of capital flows for different specifications. The coefficient is quite stable across specifications, at around 0.60 for emerging countries and 0.49 for developed countries. These coefficients imply a half-life of capital flow shocks of 16.3 months for emerging countries and 11.7 months for developed countries. The difference in the persistence of shocks explains a large part of the ratio of standard deviations between emerging and developed countries. As far as we know, no theories currently explain this different degree of persistence.

13. Broner, Lorenzoni, and Schmukler (2004) present evidence on emerging countries' sovereign debt that suggests the importance of these supply factors. See this paper and Caballero and Krishnamurthy (2003) for models in which supply-side considerations play a major role in emerging economies' access to international capital markets.

Figure 4. Autoregressive Coefficient



Source: Authors' calculations.

4. Volatility and Country Characteristics

The previous sections showed that capital flows to emerging countries are much more volatile than capital flows to developed countries. We also showed that macroeconomic variables had little explanatory power to account for this phenomenon, which was characterized instead by a set of statistical properties not obviously related to any fundamentals. In this section, we take a step back and analyze whether fundamentals can explain, if not the time series behavior of capital flows, at least its unconditional standard deviation. Our previous results indicate that the level of economic development should be a good predictor for this volatility, but it is not clear which aspect of economic development is most relevant. We thus consider three variables that are correlated with economic development but that reflect different economic characteristics of countries: per capita income, financial development, and quality of institutions.

For per capita income, we take the average real income per capita from Penn World Table for the period 1985–89. For financial development, we use the ratio of private domestic credit to GDP and the ratio of liquid liabilities to GDP in 1989 (from Loayza, Fajnzylber, and Calderón, 2005). For institutional quality, we use the first principal component of indicators on the prevalence of law and order, the quality of bureaucracy, the absence of corruption, and the accountability of public officials in 1989 (from the International Country Risk Guide). We regress capital flow volatility during the period 1990–2003 on these country characteristics. We begin our study of capital flow volatility in 1990 so as to minimize the problem of reverse causality, namely, that country characteristics in 1989 be the result of past capital flow volatility.

Table 7 shows the main results. We find that higher per capita GDP, a higher level of financial development, and a higher level of institutional quality are all associated with less volatile capital flows. The results for financial development are especially interesting. While a high level of private credit is associated with less capital flow volatility, the result is weaker for the level of liquid liabilities. The reason is probably that while the two measures reflect both financial development and, to some degree, financial vulnerability (for example, leverage), the level of liquid liabilities probably reflects financial vulnerability to a larger extent than does the level of private credit. This interpretation is reinforced by the result of the regression including both measures (regression 4). In this case, the coefficient on private credit increases in size, while the coefficient on liquid liabilities becomes positive. Given the small number of observations and the high correlation between the explanatory variables, none of them is significant when included simultaneously. If one is willing to associate p values with explanatory power, then financial development appears to retain the most explanatory power, followed by institutional quality and per capita GDP.

Table 7. Volatility Regressions[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
GDP per capita	–0.110**					–0.040
	(0.05)					(0.14)
Financial development:		–0.014*		–0.019		–0.008
private credit		(0.008)		(0.013)		(0.016)
Financial development:			–0.011	0.009		0.007
liquid liabilites			(0.011)	(0.018)		(0.018)
Institutional quality					–0.430**	–0.210
					(0.20)	(0.54)
R^2 (%)	10.8	6.9	2.6	7.5	10.4	11.3
No. observations	53	43	43	43	43	43

Source: Authors' calculations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
a. The dependent variable is the standard deviation of capital flows between 1990 and 2003. The independent variables are as of 1989, except per capita GDP, which is the average for the period 1985–89. Units are as follows: capital flows (for standard deviation) as percentage of GDP; per capita GDP in thousands of dollars; financial development as percentage of GDP (both private credit and liquid liabilities); and institutional quality as an index (in 1990 it ranges from –3.26 for Zaire (not in our sample) or –2.06 for Nigeria (in our sample) to 3.47 for Canada). Standard errors are in parentheses.

We also tried controlling for the volatility of the explanatory variables to make sure they do not affect the volatility of capital flows through their effects on the main equations. The results are in table 8. We would have liked to control for the volatility of the control variables in the 1980s, since the volatility of both controls and capital flows in the 1990s could be affected by unobserved variables. However, we only have data on volatility in the 1980s for per capita GDP, so for the other controls we could only use volatility in the 1990s. We find that controlling for the volatility of the control variables does not qualitatively affect the results of table 7, in the sense that the estimated coefficients are not statistically different. The one possible exception is institutional quality, for which the magnitude of the coefficient seems to increase. Again, when we include all four controls simultaneously, they all become insignificant. Again, if one is willing to associate p values with explanatory power, both financial development and institutional quality have a bit more explanatory power than per capita GDP.[14]

5. Final Remarks

This paper has provided a number of stylized facts about capital flows to emerging and developed countries. First, capital flows to emerging countries are much more volatile than capital flows to developed countries. Second, fundamentals, in the form of domestic and foreign macroeconomic variables, explain very little of the dynamics of capital flows. Third, fundamentals, in the form of country characteristics, explain a substantial amount of the unconditional volatility of capital flows across countries: financial development, good institutions, and high per capita income are all associated with lower volatility. Finally, although we cannot explain the dynamics of capital flows, the high volatility of capital flows to emerging countries reflects three statistical properties of capital flows: relative to developed countries, flows to emerging countries have fatter left tales (that is, emerging countries are more subject to crises), shocks to capital flows are more persistent in emerging countries, and capital flows to emerging countries are more correlated across countries.

Although our evidence is more suggestive than conclusive, it points to the importance of supply-side factors in explaining capital flows to emerging countries. The fact that domestic macroeconomic variables

14. This is the case for regression 5, but not for regression 10. Regression 5 is the one in which all four controls enter symmetrically.

Table 8. Volatility Regressions Controlling for Volatility in Explanatory Variables[a]

Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GDP per capita	–0.18***				–0.01	–0.17*				–0.22
	(0.05)				(0.15)	(0.09)				(0.18)
Financial development:		–0.018**			–0.011		–0.014			–0.011
private credit		(0.008)			(0.017)		(0.011)			(0.016)
Financial development:			–0.016		0.013			–0.007		0.006
liquid liabilities			(0.011)		(0.019)			(0.012)		(0.018)
Institutional quality				–0.83***	–0.92				–0.58*	0.04
				(0.28)	(0.59)				(0.30)	(0.56)
Standard deviation:	1.02**				0.71					
GDP 1990s	(0.47)				(0.63)					
Standard deviation:		0.079*			0.063					
private credit		(0.045)			(0.048)					
Standard deviation:		0.081		0.029						
liquid liabilities		(0.050)		(0.063)						
Standard deviation:				–3.29*	–3.23					
institutional quality				(1.72)	(1.88)					
Standard deviation:						1.00	0.01	–0.52	0.66	1.99
GDP 1980s					(1.13)	(0.87)	(0.76)	(0.96)	(1.38)	
R^2 (%)	18.4	13.6	8.6	18.0	30.9	12.1	6.9	3.8	11.5	16.0
No. observations	53	43	43	43	43	46	43	43	43	43

Source: Authors' calculations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is the standard deviation of capital flows between 1990 and 2003. The independent variables are as of 1989, except per capita GDP, which is the average for the period 1985–89. Units are as follows: capital flows (for standard deviation) as percentage of GDP; per capita GDP in thousands of dollars; financial development as percentage of GDP (both private credit and liquid liabilities); and institutional quality as an index (in 1990 it ranges from –3.26 for Zaire (not in our sample) or –2.06 for Nigeria (in our sample) to 3.47 for Canada). Standard errors are in parentheses.

have little explanatory power indicates that demand factors cannot account for much of the dynamics of capital flows to emerging countries. The importance of a common component of capital flows also suggests that external factors play an important role in explaining capital flows to emerging countries. Furthermore, the fact that crises are more important in emerging countries suggests that these external factors are subject to sudden changes. These observations are consistent with a world in which emerging countries are not fully integrated into global capital markets, but rather participate in a somewhat segmented market subject to sudden shifts in the supply of capital.

It would be wrong to conclude from this evidence that emerging countries cannot do anything to avoid being subject to very volatile capital flows. Even though fundamentals explain little of the dynamics of capital flows, they do account for a substantial fraction of the unconditional volatility of flows. Our evidence suggests that emerging countries can reduce the volatility of capital flows by improving their financial markets and institutions.

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External Conditions and Growth Performance

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A central dimension of globalization is the world trend toward larger trade and financial openness, observed in most industrial and developing economies. Openness increases the integration of world goods and capital markets, contributing to potential gains in growth and welfare. However, increased integration may also lead to heightened vulnerability to external shocks. This vulnerability may be particularly important in developing countries, given their production specialization, nondiversified sources of income, unstable policies, incomplete financial markets, and weak institutions.

A growing empirical literature addresses the links between trade openness and growth, financial openness and growth, and external shocks and growth.[1] Earlier work on trade openness finds significant, positive, and often very large effects of trade openness on growth, income levels, or income convergence.[2] Much of the this research

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1. The different strands of work are based on one of two classes of openness measures. Policy or legal measures reflect policy and regulatory restrictions or barriers imposed domestically on international trade volumes and financial flows or holdings (or both). In contrast, outcome or de facto measures reflect actual trade volumes and financial flows or stocks between the domestic economy and the rest of the world.

2. See, among others, Dollar (1992); Ben-David (1993); Sachs and Warner (1995); Edwards (1998); Frankel and Romer (1999). Edwards (1993) reviews earlier work.

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has been criticized for possible bias stemming from the endogeneity of trade to income levels or gross domestic product (GDP) growth, a lack of robustness stemming from exclusion of relevant controls, and the use of inadequate data samples and estimation techniques. Rodrik and Rodríguez (2001) report that the trade openness effects on growth are not robust to the inclusion of the country's geographic latitude, and Rodrik, Subramanian, and Trebbi (2002) find that this effect is not robust to the inclusion of institutional quality. Rigobon and Rodrik (2004), based on a technique of simultaneous-equation identification through heteroskedasticity, report negative significant effects of trade openness on per capita income levels, controlling for institutions and geography.

On the other side of the distribution, some recent work reports significant and robust effects of trade openness on growth or income levels, even after controlling for the common criticisms of omitted variables and endogeneity (see, for instance, Wacziarg, 2001; Irwin and Terviö, 2002; Alcala and Ciccone, 2004; Kose, Prasad, and Terrones, 2004). Other recent work reports more qualified results: while trade openness effects are not robust in cross-section estimations, they are significant in panel studies and robust to the inclusion of institutional variables. This is the case, for instance, of Dollar and Kraay (2003) and Wacziarg and Welch (2003). The latter study, which focuses on country episodes of trade liberalization, shows that trade shares and growth increase significantly and substantially after trade is liberalized. Finally, two recent studies look at interaction effects between trade openness measures and other variables. Kose, Prasad, and Terrones (2004) report robust positive effects of trade openness on growth and find that trade openness turns the negative effect of volatility on growth into a positive one. Alesina, Spolaore, and Wacziarg (2005) study the interaction between trade openness and country size; they find that trade openness has large effects in small countries, but these effects become zero as country size tends to maximum values in their sample.

The shorter literature on links between financial openness and growth also shows mixed results. While Quinn (1997) and Edison and others (2002) report significant positive growth effects of international financial integration for the world at large, others do not find any evidence or reject robust evidence of such effects, including Grilli and Milesi-Ferretti (1995), Kraay (1998), Rodrik (1998), and O'Donnell (2001).[3] Some studies test for the interaction between financial openness

3. Edison and others (2002) provide a survey.

and other variables in order to consider nonlinearities and nonmonotonicities in the relation between financial openness and growth. The general finding is that financial openness and external financial liberalization tend to reduce growth in countries that are not industrialized (Klein and Olivei, 1999), feature ethnic heterogeneity (Chanda, 2005), have low income (Edwards, 2001), or exhibit high black-market premiums (Arteta, Eichengreen, and Wyplosz, 2001), while financial openness tends to raise growth in countries with the opposite features. Klein (2003) reports quadratic interaction terms of financial openness with government quality and with per capita GDP, concluding that financial openness only raises growth in middle-income countries. Finally Kose, Prasad, and Terrones (2004), complementing their work on links between trade openness and growth, do not find any robust growth effects of financial openness separately, but they show that sufficiently high international financial integration turns the negative effect of volatility on growth into a positive one.

External factors relevant to open economies comprise financial and real variables associated with capital flows and trade flows, respectively. They include price variables (in particular, international interest rates and terms of trade) and quantity variables (capital flows to emerging economies). For truly small countries facing infinite demand and supply elasticities for their exports and imports of capital and goods, only price variables matter for determining domestic performance, including growth. For countries with some monopoly or monopsony power in international markets—reflecting their size or their specialization in trading differentiated goods or services (or both)—quantities matter for domestic performance, too. However, examining the growth impact of external quantity variables requires isolating its exogenous component as the relevant predetermined variable. In this vein, the global or regional supply of capital could be an adequate proxy for the supply of capital to the domestic economy, while average growth of all trading partners could be an adequate proxy for the foreign demand of exports from the domestic economy.

Most empirical growth studies use one or two external variables as controls for foreign shocks.[4] The growth rate of the terms of trade is the most widely used measure of foreign shocks; representative studies include Easterly, Loayza, and Montiel (1997), Fernández-Arias

4. Foreign shocks are measured in two ways: the rate of growth or deviation of a foreign variable from its preceding level and the standard deviation of the variable in a given period. Most growth studies choose the first.

and Montiel (2001), Loayza, Fajnzylber, and Calderón (2005), and Barro and Sala-i-Martin (2004). In most studies, positive terms-of-trade shocks turn out to be significantly positive determinants of growth. Other studies consider the growth rate of trading partners as the relevant foreign shock. For instance, Arora and Vamvakidis (2004a) find that a 1 percentage point increase in economic growth of the country's trading partners leads to an increase in domestic growth of 0.8 percentage point. They argue that this result is consistent with the literature on the impact of cross-country spillovers (Arora and Vamvakidis, 2004b; Ahmed and Loungani, 1999).

Blankenau, Kose, and Yi (2001) find that foreign real interest rate shocks explain almost one-third of output fluctuations in small open economies, as well as more than half of their fluctuations in net exports and net foreign assets. Other studies include the ratio of private capital inflows to GDP as a growth determinant and also evaluate the impact of different types of capital flows on growth (see Bosworth and Collins, 1999; Mody and Murshid, 2002; Calderón and Schmidt-Hebbel, 2003). Most of these studies find that private capital inflows have a positive impact on growth, with a stronger effect in the case of foreign direct investment.[5]

From our brief review, we conclude that the existing literature does not provide a systematic and symmetric empirical analysis of (i) the relationships between economic growth and both financial and trade openness, (ii) the role of external vulnerability reflected by foreign shocks (financial and real shocks that capture exogenous price and quantity shifts) and their influence on growth, and (iii) the interaction effects between openness measures and the corresponding foreign shocks on growth performance. This paper addresses some of these issues.

The remainder of the paper presents our empirical methodology, the data sample, and our panel data regression results on economic growth. Our empirical analysis focuses on the effects that openness and external shocks have on average economic growth. For this purpose, we study the simple linear effects of trade and financial openness, as well as various external shocks; we assess the dependence of the effect of trade and financial openness on the level of per capita income; and we examine the amplification or reduction of the effect of

5. Most of these studies instrumentalize capital inflows using lagged values, legal origin variables, or investor protection measures in order to avoid endogeneity bias from the response of capital flows to growth.

external shocks depending on the degree of trade and financial openness. A final section concludes briefly.

1. Methodology

We work with a pooled data set of cross-country and time-series observations (data details are given below). We use an estimation method that is suited to panel data, deals with static or dynamic regression specifications, controls for unobserved time- and country-specific effects, and accounts for some endogeneity in the explanatory variables. This is the generalized method of moments (GMM) for dynamic models of panel data developed by Arellano and Bond (1991) and Arellano and Bover (1995).

The general regression equation to be estimated is the following:

$$y_{i,t} = \beta' X_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} . \qquad (1)$$

where y is the dependent variable of interest, that is, economic growth; the subscripts i and t represent country and period, respectively; X is a set of time- and country-varying explanatory variables, proxies of trade and financial openness, measures of various external shocks, interaction terms, and control variables; and β is the vector of coefficients to be estimated. Finally, μ_t is an unobserved time-specific effect, η_i is an unobserved country-specific effect, and ε is the error term.

The method deals with unobserved time effects through the inclusion of period-specific intercepts. Dealing with unobserved country effects is not as simple, given the possibility that the model is dynamic and contains endogenous explanatory variables. The method therefore uses differencing and instrumentation to control for unobserved country-effects. Likewise, the method relies on instrumentation to control for joint endogeneity. Specifically, it allows relaxing the assumption of strong exogeneity of the explanatory variables by allowing them to be correlated with current and previous realizations of the error term, ε.

Parameter identification is achieved by assuming that future realizations of the error term do not affect current values of the explanatory variables, that the error term is serially uncorrelated, and that changes in the explanatory variables are uncorrelated with the unobserved country-specific effect. As Arellano and Bond (1991) and Arellano and Bover (1995) show, this set of assumptions generates moment conditions that allow the estimation of the parameters of interest. The instruments corresponding to these moment conditions are appropriately lagged values of both levels and differences of the explanatory and dependent variables (the latter if the model is dynamic). Since the moment conditions typically overidentify the regression model, the econometric technique also allows for specification testing through a Sargan-type test.

2. Sample and Results

We estimate economic growth regressions on a pooled (cross-country, time-series) data set consisting of seventy-six countries with at most six nonoverlapping five-year periods over 1970—2000 for each country. Appendix 1 lists the countries in the sample. Appendix 2 provides full definitions and sources of all variables used in the paper, and appendix 3 presents basic descriptive statistics for the data used in the regressions.

As is standard in the literature, the dependent variable is the average rate of real per capita GDP growth. The regression equation is dynamic in the sense that it includes the initial level of per capita GDP as an explanatory variable. As additional control variables, the regression includes the average rate of secondary school enrollment to account for human capital investment, the average ratio of private credit to GDP as a measure of financial depth, the average inflation rate to account for monetary discipline, and the average ratio of government consumption to GDP as a measure of the government burden. The regression equation also allows for both unobserved time- and country-specific effects.

The explanatory variables of interest are measures of trade and financial openness, measures of external shocks, and various interaction terms. Given that we want to evaluate the effect of actual exposure to international markets on economic growth, we work with outcome measures of trade and financial openness. These measures are related to policies, but they are also the result of structural characteristics of the economy, such as size, natural and social endowments, and public infrastructure. The outcome measures we use are the ratio of exports and imports to GDP in the case of trade and the ratio of portfolio and foreign direct investment (FDI) liabilities to GDP in the case of financial openness.

We consider four types of external shocks: the first two are primarily related to trade in goods, and the latter two are mainly related to financial transactions. All four are defined so that they can be considered exogenous to the country in question. They are the average growth of the terms of trade, the average weighted output growth rate of trade partners, the average amount of capital flows to the region where the country is located, and the average change of the international interest rate. Whereas the first two variables vary by country and period, the third varies only by region and period and the fourth only by period. Because of its limited sample variation, the effect of the international interest rate shock cannot be distinguished from the unobserved time-specific effect; however, its interaction with the measures of trade and financial openness can be considered.

2.1 Linear Effects of Openness and External Shocks

In the basic case, the effects of openness and shocks on growth are independent from each other and independent from other characteristics of the economy. This corresponds to the most common treatment of growth determinants in the literature. We estimate the following regression equation in this case:

$$y_{i,t} = \beta_0' \mathrm{CV}_{i,t} + \beta_1' \mathrm{OPEN}_{i,t} + \beta_2' \mathrm{EXT}_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \,. \tag{2}$$

where CV is the set of control variables, OPEN is the set of openness variables, and EXT is the set of foreign-shock variables.

The estimation results are presented in table 1. We find that both trade and financial openness are positively related to economic growth. As mentioned in the introduction, the effect of openness on growth is found to be ambiguous in the literature. However, ambiguity gives way to positive effects when the time-series dimension is taken into account: the beneficial impact of openness is most clearly seen in the experience of countries before and after liberalization (see, for instance, Wacziarg and Welch, 2003). Our panel data results confirm this finding, as they are based not only on cross-country comparisons, but also on changes over time for individual countries. Furthermore, since our methodology controls for country-specific effects and the joint endogeneity of openness, our results are not subject to the criticism that the positive growth effect of openness is not robust to the inclusion of variables such as geographical location (see Rodrik and Rodríguez, 2001, for the case of trade) or is due to reverse causation.

The growth effects of external shocks are all significant and carry the expected signs. That is, increases in favorable terms of trade, in the growth rate of trade partners, and in capital flows to the region

Table 1. Economic Growth, Trade Openness, Financial Openness and Foreign Shocks[a]

Explanatory variable	*Baseline regression*
Constant	7.142 **
	(2.25)
Control variables	
Initial GDP per capita (in logs)	–0.177 **
	(0.09)
Education (secondary enrollment, in logs)	1.058 **
	(0.16)
Financial depth (private domestic credit to GDP, in logs)	0.631 **
	(0.10)
Lack of price stability (inflation rate, in log[100 + inf. rate])	–2.275 **
	(0.37)
Government burden (government consumption to GDP, in logs)	–1.488 **
	(0.22)
Openness	
Trade openness (real exports and imports to GDP, in logs)	0.403 **
	(0.13)
Financial openness (stock of equity-related foreign liabilities, in logs)	0.051**
	(0.01)
Foreign shocks	
Terms-of-trade shocks (growth rate of terms of trade)	0.038 **
	(0.01)
Foreign growth (growth rate of the country's trading partners)	1.536 **
	(0.17)
Regional capital inflows (private capital inflows to country's region)	0.098 **
	(0.02)
Period shifts	
1976–80 period	–1.119 **
1981–85 period	–1.284 **
1986–90 period	–1.865 **
1991–95 period	–0.517 *
1996–2000 period	–1.843 **
Summary statistic	
Specification tests (*p* values)	
Sargan test	(0.41)
Second-order correlation	(0.90)
No. countries / No. Observations	76 / 438

Source: Authors' calculations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
a. The dependent variable is growth in real per capita GDP. The estimation method is the general method of moment instrumental variables (GMM-IV) system developed by Arellano and Bover (1995) and Blundell and Bond (1998). Our sample covers seventy-six countries over the period 1970–2000 (in five-year-period observations). Robust standard errors are in parentheses.

produce a rise in average economic growth. These results, together with the estimated size and significance of the period shifts, confirm the substantial importance of external conditions as growth determinants.

All control variables carry significant coefficients with the expected signs. The Sargan and serial-correlation specification tests do not reject the null hypothesis of correct specification, lending support to our estimation results. This is the case in all exercises presented below, and to avoid redundancy we only mention it here.

2.2 The Effect of Openness Depending on the Level of Income

It is increasingly held that the growth effect of openness may not be homogeneous across countries. Some researchers, in part motivated by the work of Klein and Olivei (1999) in the case of financial openness, consider the possibility that the growth effect of openness may depend on country characteristics such as income and institutional quality (see Edwards, 2001; Klein, 2003). In the framework of our panel data methodology, we now reassess this possibility by allowing the effect of each measure of openness to vary with the level of real per capita GDP, which serves as a proxy for overall development. We do this by interacting each openness measure with linear and quadratic per capita GDP (INC) in each country at the start of the corresponding period. The regression equation we estimate in this case is the following:

$$\begin{aligned} y_{i,t} &= \beta_0'\mathrm{CV}_{i,t} + \beta_1'\mathrm{OPEN}_{i,t} + \beta_2'\mathrm{EXT}_{i,t} + \beta_3'\mathrm{OPEN}_{i,t} * \mathrm{INC}_{i,t} \\ &\quad + \beta_4'\mathrm{OPEN}_{i,t} * \mathrm{INC}_{i,t}^2 + \mu_t + \eta_i + \varepsilon_{i,t}. \end{aligned} \tag{3}$$

Table 2 presents the estimation results. We consider the interaction between per capita GDP and the openness variables one at a time; this simplifies the interpretation of the results without overextending the parameter requirements on the data. Thus, column 1 shows the results when financial openness is interacted with income, and column 2, when trade openness is interacted with income. The regression results are qualitatively similar whether we deal with financial or trade openness and can be summarized as follows. The coefficient on the openness indicator by itself is negative and significant, and the coefficients on the linear and quadratic interaction terms are significantly positive and negative, respectively. The growth effect of openness then depends on per capita income or, taking a broader interpretation, on the overall level of development. A corollary is that the net growth effect could, in theory, be positive or negative, and we should examine which is the case for the actual levels of per capita GDP found in our sample.

Figure 1 illustrates what the estimated pattern of coefficients implies for the change in growth produced by an increase in each openness measure. Specifically, the figure uses the regression point estimates to plot the growth effect of a one-standard-deviation increase in openness as a function of per capita GDP for the full range of the sample. For both financial and trade openness, the growth effect is nearly zero for low levels of per capita GDP, it increases at a decreasing rate as income rises, and it reaches a maximum at high levels of income (higher in the case of trade openness). The growth effect of openness appears to be economically significant for middle- and high-income countries. In relation to the previous literature, we also find nonlinear growth effects of openness, but the precise nature of the nonlinearity differs. For instance, we do not find negative effects of financial openness for low-income countries (in contrast with Edwards, 2001), and we find that the growth effects of financial openness remain positive even for high-income countries (unlike Klein, 2003). However, we agree with these papers that middle-income countries can expect to improve their growth performance as they become more integrated with the rest of the world.

Our coefficient estimates suggest significant economic effects. For instance, a one-standard-deviation increase in the degree of financial openness would lead to higher per capita growth rates by 0.70 percentage point for countries in the twenty-fifth percentile of the world distribution of output per capita for the 1996–2000 period (Honduras and Zimbabwe); by 0.85 percentage point for countries in the seventy-fifth percentile (Spain and Israel); and by 0.76 percentage point for countries in the ninety-fifth percentile (Japan). The highest growth effect of international financial integration (0.90 percentage point) is achieved by middle-income countries in the sixty-seventh percentile (namely, Chile, Mexico, and South Africa). Similarly, an analogous increase in the degree of trade openness will generate an increase in the per capita GDP growth rate of 0.40 percentage point for countries in the twenty-fifth percentile, 0.57 percentage point for median countries (such as Paraguay and Tunisia), 0.70 percentage point for countries in the seventy-fifth percentile, and 0.75 percentage point for countries in the ninety-fifth percentile of the world distribution of output per capita.

Table 2. Economic Growth and the Interaction between Openness and Real GDP per Capita[a]

	Outcome measures of openness	
Explanatory variable	*Financial* *(1)*	*Trade* *(2)*
Constant	2.105	23.419**
	(2.57)	(2.37)
Control variables		
Initial GDP per capita (in logs)	–0.704**	–2.883**
	(0.24)	(0.27)
Education (secondary enrollment, in logs)	2.443**	2.062**
	(0.24)	(0.15)
Financial depth (private domestic credit to GDP, in logs)	0.354**	0.402**
	(0.15)	(0.13)
Lack of price stability (inflation rate, in log[100 + inf. rate])	–1.434**	–1.605**
	(0.43)	(0.34)
Government burden (government consumption to GDP, in logs)	–1.184**	–1.460**
	(0.24)	(0.32)
Openness		
Trade openness (real exports and imports to GDP, in logs)	0.449**	–8.214**
	(0.10)	(0.77)
Financial openness (stock of equity-related foreign liabilities, in logs)	–2.274**	–0.050**
	(0.35)	(0.01)
Openness * Initial GDP per capita	0.562**	1.832**
	(0.10)	(0.19)
Openness * Initial GDP per capita squared	–0.031**	–0.089**
	(0.01)	(0.01)
Foreign shocks		
Terms-of-trade shocks (growth rate of terms of trade)	0.041**	0.055**
	(0.01)	(0.01)
Foreign growth (growth rate of the country's trading partners)	1.749**	1.666**
	(0.12)	(0.11)
Regional capital inflows (private capital inflows to country's region)	0.115**	0.115**
	(0.03)	(0.03)
Period shifts		
1976–80 period	–1.359**	–1.110**
1981–85 period	–1.627**	–1.099**
1986–90 period	–2.322**	–1.873**
1991–95 period	–0.832**	–0.260
1996–2000 period	–2.610**	–1.609**
Summary statistic		
Specification tests (*p* values)		
Sargan test	(0.18)	(0.45)
Second-order correlation	(0.94)	(0.79)
No. countries / No. Observations	76 / 438	76 / 438

Source: Authors' calculations.

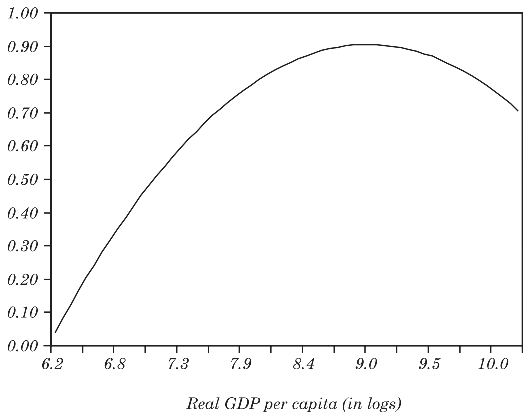
* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

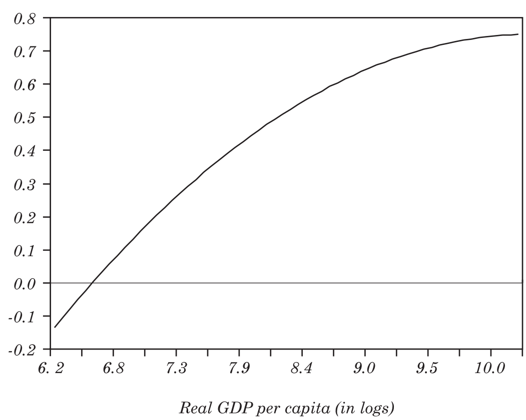
a. The dependent variable is growth in real per capita GDP. The estimation method is the GMM-IV system developed by Arellano and Bover (1995) and Blundell and Bond (1998). Our sample covers seventy-six countries over the period 1970–2000 (in five-year-period observations). Robust standard errors are in parentheses.

Figure 1. Growth Effect of Openness as a Function of GDP per Capita

A. Growth effect of outcome financial openness as a function of GDP per capita



B. Growth effect of outcome trade openness as a function of GDP per capita



Source: Authors' calculations.

2.3 The Interaction between Openness and External Shocks

The previous exercises focus on the potential effect that openness can have on economic growth, controlling for various external shocks. An additional issue is whether openness makes the economy more or less responsive to external shocks. Ideally, openness should amplify the growth effect of positive shocks and dampen the effect of negative ones. However, we find no evidence of asymmetric interaction effects (in results not presented here) and limit ourselves to the issue of whether the growth effect of shocks depends on the economy's openness. We address this question by considering interaction terms between each of the shocks and the openness variables. The regression equation we estimate in this case is the following:

$$\begin{aligned} y_{i,t} &= \beta_0' \mathrm{CV}_{i,t} + \beta_1' \mathrm{OPEN}_{i,t} + \beta_2' \mathrm{EXT}_{i,t} \\ &\quad + \beta_3' \mathrm{OPEN}_{i,t} * \mathrm{EXT}_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t}. \end{aligned} \tag{4}$$

These interactions present a large number of possibilities, but we consider the interactions between financial and trade openness indicators with the external shocks one shock at a time to avoid overextending the parameter requirements on the data. This also allows us to simulate the effect of each shock independently. The results are presented in table 3, with each column devoted to the interactions with each of the four external shocks. An interesting pattern emerges. Larger trade openness decreases the growth effect of trade-related shocks (the growth of terms of trade and the GDP growth of trade partners) while increasing the growth effect of financial market shocks (international interest rate changes and regional capital inflows). Conversely, greater financial openness increases the growth effect of trade-related shocks while reducing the impact of regional capital inflows, one of the financial market shocks. The exception to this pattern is that financial openness seems to increase the growth effect of international interest rate changes. Except for the latter case, the results challenge the conventional wisdom that trade openness increases vulnerability to trade-related shocks and that financial openness does likewise with financial-related shocks. The channels of transmission seem to be more complex.

Since the growth effect of a shock now depends on three coefficients plus the levels of trade and financial openness, the net effect is not immediately clear. Figure 2 helps to make this assessment by

Table 3. Economic Growth and the Interaction between Openness and Foreign Shocks[a]

Explanatory variable	Terms-of-trade changes *(1)*	Foreign growth *(2)*	World interest rate changes *(3)*	Regional capital inflows *(4)*
Constant	5.242**	12.005**	9.444**	10.804**
	(2.41)	(2.94)	(2.44)	(3.06)
Control variables				
Initial GDP per capita (in logs)	–0.138*	–0.280**	–0.176*	–0.152*
	(0.09)	(0.13)	(0.11)	(0.09)
Education	1.284**	1.419**	1.110**	0.977**
(secondary enrollment, in logs)	(0.19)	(0.19)	(0.17)	(0.16)
Financial depth	0.592**	0.669**	0.578**	0.628**
(private domestic credit to GDP, in logs)	(0.07)	(0.14)	(0.11)	(0.10)
Lack of price stability	–1.786**	–3.936**	–2.400**	–2.733**
(inflation rate, in log[100 + inf. rate])	(0.39)	(0.33)	(0.42)	(0.49)
Government burden	–1.597**	–1.523**	–1.547**	–1.384**
(government consumption to GDP, in logs)	(0.24)	(0.28)	(0.26)	(0.23)
Openness				
Trade openness (stock of equity-related	0.133*	1.227**	0.404**	–0.190
foreign liabilities, in logs)	(0.08)	(0.46)	(0.12)	(0.15)
Financial openness	0.080**	–0.159**	0.071**	0.146**
	(0.01)	(0.04)	(0.01)	(0.02)
Foreign shocks:				
Terms-of-trade shocks	1.175**	0.033**	0.050**	0.039**
(growth rate of terms of trade)	(0.12)	(0.01)	(0.01)	(0.01)
Foreign growth (growth rate	1.703**	2.756**	1.499**	1.618**
of the country's trading partners)	(0.17)	(0.75)	(0.16)	(0.19)
Regional capital inflows (private	0.025	0.057**	0.086**	–0.374**
capital inflows to country's region)	(0.02)	(0.01)	(0.02)	(0.12)
Interaction: openness and foreign shock				
Trade openness * foreign shock	–0.276**	–0.361*	0.397**	0.151**
	(0.03)	(0.19)	(0.11)	(0.03)
Financial openness * foreign shock	0.010**	0.067**	0.118**	–0.043**
	(0.00)	(0.02)	(0.02)	(0.01)
Period shifts				
1976–80 period	–1.239**	–1.087**	–5.122**	–0.993**
1981–85 period	–1.413**	–1.290**	–2.605**	–1.099**
1986–90 period	–2.495**	–1.807**	–3.443**	–1.638**
1991–95 period	–0.564**	–0.545*	–1.359**	–0.169
1996–2000 period	–1.900**	–1.911**	–3.075**	–1.604**
Summary statistic				
Specification tests (*p* values)				
Sargan test	(0.22)	(0.38)	(0.37)	(0.38)
Second-order correlation	(0.81)	(0.59)	(0.96)	(0.67)
No. countries / No. observations	76 / 438	76 / 438	76 / 438	76 / 438

Source: Authors' calculations.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

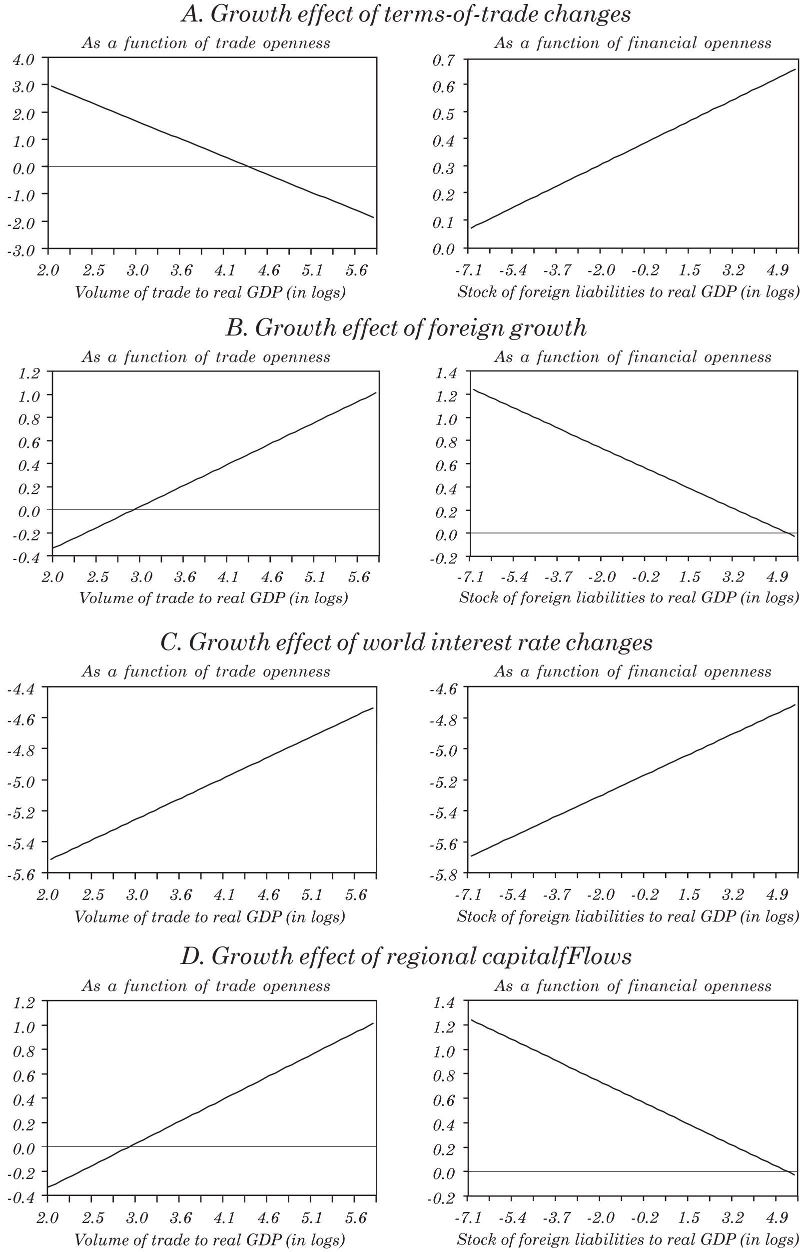
a. The dependent variable is growth in real per capita GDP. The estimation method is the GMM-IV system developed by Arellano and Bover (1995) and Blundell and Bond (1998). Our sample covers seventy-six countries over the period 1970–2000 (in five-year-period observations). Robust standard errors are in parentheses.

graphing the growth effect of one-standard-deviation increase in each shock as a function of, first, trade openness and, second, financial openness (in the former case, we use the sample average of financial openness in the calculation of the partial effects; in the latter, the sample average of trade openness).[6] For the terms-of-trade shock, the growth effect is positive for low and medium levels of trade openness, but the growth effect changes signs and becomes negative as trade openness increases further. The growth effect of the terms-of-trade shock increases with financial openness and is positive throughout the relevant range. Regarding the trade partners' growth shock, as noted above, the effect decreases with trade openness and increases with financial openness, but it is always positive in both cases. In the case of the international interest rate shock, the direct impact on growth cannot be separated from the time effects. We estimate that the direct impact is negative, however, based on an exercise in which we compare the period shifts with and without the interest rate shock interactions. Once we take into account the interactions, the total growth effect of interest shocks continues to be negative, but it approaches zero as either type of openness rises. Finally, the direct impact of the capital flow shock is negative, although the total effect on growth is positive once the openness interactions are taken into account, with larger trade openness increasing its growth effect and financial openness reducing it.

We can use the numbers to draw several quantitative implications. First, given an average level of financial openness, a one-standard-deviation decline in the terms of trade would lead to a fall in real per capita GDP growth of 0.55 percentage point for countries in the twenty-fifth percentile of the distribution of trade openness across the world in the 1996–2000 period (namely, Greece, with exports and imports representing almost 50 percent of GDP). For median countries—such as Venezuela and Portugal—the growth decline stemming from a deterioration in the terms of trade is smaller (0.13 percentage point) thanks to their higher trade openness. The growth effect of declining terms of trade would be null for countries in the ninetieth percentile (like Australia). Second, given an average level of financial openness, a one-standard-deviation decline in the growth rate of a country's trading partners would lead to a reduction in the growth rate of 0.90 percentage point for countries in the twenty-fifth percentile of the distribution of

6. For these simulations, we restrict the range of the financial openness indicator to values at which the stock of foreign liabilities is positive.

Figure 2. Growth Effect of External Shocks as a Function of Openness



Source: Authors' calculations.

trade openness. The reduction of the growth rate would be smaller, at approximately 0.75 percentage point, for countries in the seventy-fifth percentile (Israel). Third, given an average level of trade openness, a one-standard-deviation decline in the capital flows to the country's region would generate a reduction in the country's growth rate of 0.23 percentage point for countries in the twenty-fifth percentile of the distribution of financial openness across the world for the 1996–2000 period (Greece), 0.17 percentage point for median countries in the distribution (South Africa), and 0.12 percentage point for countries in the seventy-fifth percentile (Chile and Spain).

Finally, openness and external shocks may have a significant effect on macroeconomic volatility, and this, in turn, has been found to have a harmful influence on economic growth (see Fatás, 2002; Hnatkovska and Loayza, 2004). Therefore, the growth effects of openness and external shocks that we just described might occur through their impact on macroeconomic volatility.[7] To consider this possibility, we add the standard deviation of economic growth as an additional explanatory variable. The results are presented in table 4. Growth volatility carries the expected negative and significant coefficient, but the coefficients on all other relevant variables retain their sign, significance, and, to a large extent, size. The growth effects of openness, external shocks, and their interactions can thus be considered independently of their volatility effects.

3. Conclusions

The goal of this paper was to provide a systematic empirical assessment of the impact of openness and external shocks—as well as their interactions—on economic growth. To accomplish this task, we ran linear and nonlinear growth regressions on a cross-country panel data set spanning seventy-six countries for the 1970–2000 period. We considered outcome (or de facto) measures of both trade and financial openness and used four types of external shocks. Trade openness was proxied by the ratio of the volume of imports plus exports to GDP, and financial openness by the ratio of foreign liabilities to GDP. Under the assumption that no country faces a perfectly elastic demand for its products or has unobstructed access to financial markets, we considered not only price, but also quantity proxies for external shocks. Two of

7. According to the estimates presented in table 4, a one-unit reduction in the standard deviation of real GDP growth would lead to an increase in economic growth between 0.35 and 0.40 percentage point.

Table 4. Economic Growth and the Interaction between Openness and Foreign Shocks: Controlling for Macroeconomic Volatility[a]

Explanatory variable	Terms-of-trade changes *(1)*	Foreign growth *(2)*	World interest rate changes *(3)*	Regional capital inflows *(4)*
Constant	0.139	1.107	2.011	4.385**
	(1.85)	(1.81)	(2.08)	(1.91)
Control variables				
Initial GDP per capita (in logs)	–0.284*	–0.226*	–0.342*	–0.351**
	(0.16)	(0.13)	(0.18)	(0.13)
Education (secondary enrollment, in logs)	1.233**	0.861**	0.821**	0.836**
	(0.20)	(0.12)	(0.19)	(0.12)
Financial depth	0.670**		0.826**	
(private domestic credit to GDP, in logs)	1.080**		0.972**	
	(0.18)	(0.15)	(0.18)	(0.16)
Lack of price stability	–0.390	–1.138**	–0.522*	–0.999**
(inflation rate, in log[100 + inf. rate])	(0.32)	(0.17)	(0.35)	(0.23)
Government burden	–1.622**	–1.583**	–1.660**	–1.345**
(government consumption to GDP, in logs)	(0.26)	(0.22)	(0.30)	(0.22)
Openness				
Trade openness (real exports and	0.573**	1.380**	0.616**	0.118
imports to GDP, in logs)	(0.13)	(0.33)	(0.13)	(0.15)
Financial openness (stock of equity-	0.029**	–0.203**	0.034**	0.111**
related foreign liabilities, in logs)	(0.01)	(0.03)	(0.01)	(0.01)
Foreign shocks				
Terms-of-trade shocks	0.917**	0.038**	0.042**	0.036**
(growth rate of terms of trade)	(0.15)	(0.01)	(0.01)	(0.01)
Foreign growth (growth rate of the	1.457**	2.573**	1.457**	1.477**
country's trading partners)	(0.17)	(0.50)	(0.16)	(0.16)
Regional capital inflows (private	0.029	0.049**	0.063**	–0.233*
capital inflows to country's region)	(0.03)	(0.02)	(0.03)	(0.14)

these are related to international trade (changes in the terms of trade and the growth rate of country trading partners), and two are related to financial markets (changes in international real interest rates and regional capital inflows).

We conducted three types of exercises. The first follows the most common growth regression specification and consists of estimating the linear effects of trade and financial openness, as well as external shocks. The second assesses whether the effect of trade and financial openness depends on the country's level of per capita income. Finally, the third exercise examines whether trade and financial openness amplifies or dampens the growth effects of external shocks.

Table 4. (continued)

Explanatory variable	Terms-of-trade changes *(1)*	Foreign growth *(2)*	World interest rate changes *(3)*	Regional capital inflows *(4)*
Interaction: openness and foreign shock				
Trade openness * Foreign Shock	–0.215**	–0.346**	0.311**	0.105**
	(0.04)	(0.12)	(0.13)	(0.04)
Financial openness * Foreign Shock	0.004**	0.089**	0.101**	–0.039**
	(0.00)	(0.01)	(0.02)	(0.01)
Macroeconomic volatility				
Standard Deviation of the Growth	–0.380**	–0.401**	–0.354**	–0.395**
Rate of Real GDP per capita	(0.02)	(0.02)	(0.02)	(0.02)
Period shifts				
1976–80 period	–1.324**	–1.187**	–4.458**	–1.252**
1981–85 period	–1.704**	–1.491**	–2.587**	–1.486**
1986–90 period	–2.624**	–2.099**	–3.512**	–2.043**
1991–95 period	–0.974**	–0.629*	–1.306**	–0.497
1996–2000 period	–2.457**	–2.173**	–3.200**	–2.093**
Summary statistic				
Specification tests (*p* values)				
Sargan test	(0.22)	(0.27)	(0.24)	(0.46)
Second-order correlation	(0.94)	(0.62)	(0.78)	(0.74)
No. countries / No. observations	76 / 438	76 / 438	76 / 438	76 / 438

Source: Authors' calculations.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

a. The dependent variable is growth in real per capita GDP. The estimation method is the GMM-IV system developed by Arellano and Bover (1995) and Blundell and Bond (1998). Our sample covers seventy-six countries over the period 1970–2000 (in five-year-period observations). Robust standard errors are in parentheses.

When we considered the simple linear specification we found that both trade and financial openness are positively related to economic growth. Our panel data results confirm the finding that when evidence over time is jointly considered with cross-country comparisons, openness emerges as an engine for growth. Given our econometric methodology, these results are not subject to the criticism that the positive growth effect of openness is not robust to the inclusion of variables such as geographical location or is due to reverse causation. Regarding the growth effects of external shocks, we find that increases in favorable terms of trade, in the growth rate of trade partners, and in capital flows to the region produce a rise in economic growth. These results corroborate the substantial importance of external conditions as growth determinants.

When we expanded our regression specification to consider the interaction between openness and the level of income, we found interesting nonlinearities. The regression results are qualitatively similar for financial or trade openness: in both cases, the growth effect is nearly zero for low levels of per capita GDP, it increases at a decreasing rate as income rises, and it reaches a maximum at high levels of income (higher in the case of trade openness). The growth effect of trade and financial openness appears to be economically significant for middle- and high-income countries.

Finally, on the question of the amplification of external shocks through openness, we uncovered an interesting and rather unexpected pattern: larger trade openness dampens the growth effect of trade-related shocks while amplifying the effect of financial market shocks. Conversely, larger financial openness increases the growth effect of trade-related shocks while attenuating the impact of regional capital inflows (one of the financial market shocks). These results challenge the conventional wisdom that trade openness increases the vulnerability to trade-related shocks and that financial openness does likewise with financial-related shocks.

All in all, our assessment of the growth effects of external conditions is quite positive regarding the beneficial impact of trade and financial openness. However, the fact that these effects change with the level of development presents an interesting avenue for future research: finding precisely under what conditions of macroeconomic stability, public infrastructure, market flexibility, and human capital does integration to international markets offer the greatest promise for growth.

Appendix A
Sample of Countries

Our sample of seventy-six countries breaks down as follows.

— Industrial economies (twenty-two countries): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

— Latin America and the Caribbean (twenty-one countries): Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, and Venezuela.

— East Asia and the Pacific (eight countries): China, Indonesia, Korea, Malaysia, Papua New Guinea, the Philippines, Singapore, and Thailand.

— Middle East and North Africa (seven countries): Algeria, Egypt, Israel, Jordan, Morocco, Tunisia, and Turkey.

— South Asia (three countries): India, Pakistan, and Sri Lanka.

— Sub-Saharan Africa (fifteen countries): Botswana, Cote d'Ivoire, the Gambia, Ghana, Kenya, Madagascar, Malawi, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Togo, Zambia, and Zimbabwe.

APPENDIX B

Definitions and Sources of Variables Used in Regression Analysis

Table B1

Variable	*Definition and construction*	*Source*
GDP per capita	Ratio of total GDP to total population. GDP is in 1985 PPP-adjusted US$.	Authors' construction using Summers and Heston (1991) and World Bank (2002).
GDP per capita growth	Log difference of real GDP per capita.	Authors' construction using Summers and Heston (1991) and World Bank (2002).
Initial GDP per capita	Initial value of ratio of total GDP to total population. GDP is in 1985 PPP-adjusted US$.	Authors' construction using Summers and Heston (1991) and World Bank (2002).
Education	Ratio of total secondary enrollment, regardless of age, to the population of the age group that officially corresponds to that level of education.	World Bank (2004).
Financial depth	Ratio of domestic credit claims on private sector to GDP.	Author's calculations using data from IFS, central bank publications, and Penn World data. The calculation method is based on Beck, Demirgüç-Kunt, and Levine (1999).
Trade openness	Log of the ratio of exports and imports (in 1995 US$) to GDP (in 1995 US$).	World Bank (2004).
Financial openness	Log of the stock of equity-based foreign liabilities to GDP (both expressed in 1995 US$). Following Eichengreen and Irwin (1998), we add the value of one to the stock to include cases in which the stock of foreign liabilities is zero.	Lane and Milesi-Ferretti (2001, 2003), and the IMF's Balance-of-Payments Statistics
Government burden	Log of the ratio of government consumption to GDP.	World Bank (2002).
CPI	Consumer price index (1995 = 100) at the end of the year.	Author's calculations with data from IFS.

Table B1 (continued)

Variable	*Definition and construction*	*Source*
Inflation rate	Annual percent change in CPI.	Author's calculations with data from IFS.
Terms of trade	Net barter terms of trade index (1995=100).	World Bank (2004).
Terms-of-trade changes	Log differences of the terms of trade index.	Authors' construction using World Bank (2002).
Foreign growth	Growth in main trading partners calculated as the trade-weighted growth for the main trading partners of the corresponding country.	Authors' construction using Summers and Heston (1991), World Bank (2002), and the IMF's Direction of Trade Statistics.
World nominal interest rate	G-3 (United States, Germany, and Japan) money market rate (period average).	Author's calculations with data from IFS.
World inflation	G-3 (United States, Germany, and Japan) consumer price index (CPI) inflation rate.	Author's calculations with data from IFS.
World real interest rate	World nominal interest rate minus world inflation.	Author's calculations with data from IFS.
Regional capital inflows	(Gross) capital inflows (FDI, portfolio-equity, loans) to the region of the corresponding country.	Author's calculations with data from the IMF's Balance-of-Payments Statistics.
Macroeconomic volatility	Standard deviation of the growth rate of real GDP.	Authors' construction using Summers and Heston (1991) and World Bank (2002).
Period-specific shifts	Time dummy variables.	Authors' construction.

Appendix C
Descriptive Statistics for Growth Regressions

This section reports descriptive statistics for univariate and bivariate growth regressions. Data are five-year-period averages over 1970–2000 for seventy-six countries, resulting in 438 observations.

Table C1. Univariate Regressions

Variable	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Growth rate of GDP per capita	1.422	2.642	–7.944	10.128
Initial GDP per capita (in logs)	8.522	0.989	6.243	10.240
Secondary enrollment (in logs)	3.739	0.788	0.113	4.923
Private domestic credit/GDP (in logs)	3.485	0.844	0.568	5.435
Inflation (in log [100+inf. rate])	4.743	0.175	4.585	6.135
Government consumption /GDP (in logs)	2.680	0.371	1.475	3.637
Trade openness	3.948	0.594	2.024	5.787
Financial openness	1.689	3.779	–21.044	5.536
Terms-of-trade changes	–0.424	4.644	–18.859	21.415
Foreign growth	2.244	0.606	0.834	3.833
World interest rate changes	–0.017	0.658	–0.975	1.505
Regional capital flows	3.419	2.359	–1.635	10.336

Source: Author's calculations.

Table C2. Bivariate Correlations between Growth and Determinants

Variable	*Growth rate of GDP per capita*	*Initial GDP per capita (in logs)*	*Secondary enrollment (in logs)*	*Private domestic credit/GDP (in logs)*	*Inflation (in log [100+inf. rate])*	*Government consumption /GDP (in logs)*	*Trade openness*	*Financial openness*	*Terms-of-trade changes*	*Foreign growth*	*World interest rate changes*	*Regional capital inflows*
Growth rate of GDP per capita	1.00											
Initial GDP per capita (in logs)	0.19	1.00										
Secondary enrollment (in logs)	0.22	0.80	1.00									
Private domestic credit/GDP (in logs)	0.25	0.71	0.61	1.00								
Inflation (in log [100+inf. rate])	–0.29	–0.10	0.00	–0.35	1.00							
Government consumption/GDP (in logs)	–0.03	0.36	0.29	0.35	–0.10	1.00						
Trade openness	–0.04	–0.14	–0.13	0.01	–0.30	0.27	1.00					
Financial openness	0.15	0.34	0.44	0.28	0.04	0.03	–0.11	1.00				
Terms-of-trade changes	0.10	0.07	0.03	0.04	–0.12	–0.04	0.08	0.06	1.00			
Foreign growth	0.28	–0.14	–0.24	–0.12	–0.17	–0.15	–0.12	–0.23	0.08	1.00		
World interest rate changes	0.04	–0.01	–0.02	0.00	0.03	0.05	–0.01	0.03	0.20	0.29	1.00	
Regional capital flows	0.19	0.44	0.34	0.41	–0.29	0.18	0.12	0.17	0.11	–0.14	0.06	1.00

Source: Authors' calculations.

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Business Cycle Responses and the Resilience of the Chilean Economy

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After marked fluctuations in the business cycle over the last fifty years, the Chilean economy now appears to be less volatile and more resilient to external shocks. Because Chile is a small and increasingly open economy, analysts have long suspected that the amplitude of the cyclical fluctuations in the business cycle is closely related to changes in external conditions.[1]

However, many open questions remain in this regard. To what extent are the pronounced output fluctuations associated with ups and downs in external conditions, and to what extent can they be attributed to domestic sources? Are real or financial external shocks the most important source of fluctuations? Has the increasing international integration implied greater synchronization of the

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1. For a review of empirical regularities characterizing business cycles in Chile, see Belaisch and Soto (1998) and Bergoeing and Suarez (2001). For a real business cycle (RBC) model applied to Chilean data, see Bergoeing and Soto (2005).

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domestic cycle with external economic conditions? If so, does this imply greater external vulnerability, or has resilience to external shocks improved somewhat?

To address these questions, we adopt an empirical approach using a vector autoregressive (VAR) model with block exogeneity. We adapt the VAR model to the behavior of a small open economy and then use it to characterize and decompose the behavior of the Chilean business cycle. Since our model includes a comprehensive set of variables, we can evaluate the importance of external, policy, and other domestic variables for the business cycle. We are thus able to assess how the economy has responded to different stochastic disturbances, measure the contribution of these variables to the business cycle fluctuations, and analyze the resilience of the Chilean economy over the last half century.

A key feature in our analysis is that we impose some plausible restrictions on relations among variables, following recent developments in model specification and VAR estimation procedures. Following Cushman and Zha (1997), Dungey and Pagan (2000), Hoffmaister and Roldós (2001), and Buckle and others (2002), we use block exogeneity for international variables to capture the small open economy feature in the associated dynamic responses and for domestic policy variables to deal with identification issues.

Several interesting results emerge from this analysis. First, real and financial external shocks have significant effects on domestic economic activity. The significant impact on the cyclical behavior of the economy following external financial shocks (represented by the volatility of the international financial markets and net capital inflows) reflects the financial restrictions faced by an emerging economy like Chile. Among domestic policy shocks, demand management policies and structural policies affect business cycle fluctuations, as do other domestic shocks such as investors confidence. Altogether, however, foreign shocks have been the dominant source of domestic output fluctuations, followed by monetary policy and structural policies. Fiscal policy and domestic equity explain a relatively low fraction of the volatility of the business cycle. Second, we provide evidence of an increase in the Chilean economy's resilience to external shocks in the 1990s. This positive development has taken place even as the economy's deepening integration with the rest of the world has increased the synchronization of the domestic business cycle with international conditions. This trend underscores the significant countercyclical role played by policies.

The paper is organized as follows. Section 1 provides a historical overview of the Chilean economy since 1950, outlining the main issues related to growth, recessions, and cyclical behavior. Section 2 describes the data and the methodological issues associated with the VAR framework. Section 3 analyzes the impact of foreign, policy, and other domestic shocks on the business cycle and the sources of its fluctuations, while section 3 uses historical decomposition analysis to provide insights on the economy's resilience to shocks. The final section summarizes our results and their implications for economic policy.

1. Historical Overview of the Chilean Economy since 1950

The GDP growth rate of the Chilean economy displayed an upward-sloping trend over the last half of the century, starting at around 3 percent in the early 1950s, hitting a midpoint of around 4 percent in the early 1970s, and ending at around 5 percent in 2003 (the last year of the sample period). The initial period was characterized by frequent, but relatively moderate peaks and troughs, with a somewhat low, but stable medium-term growth rate. Between the 1970s and the 1990s, however, two very deep recessions took place, with troughs in 1975 and 1982, respectively.[2] From 1990 onward, the peaks and troughs were as moderate as in the first period, but with a significantly higher medium-term growth rate (see figure 1).

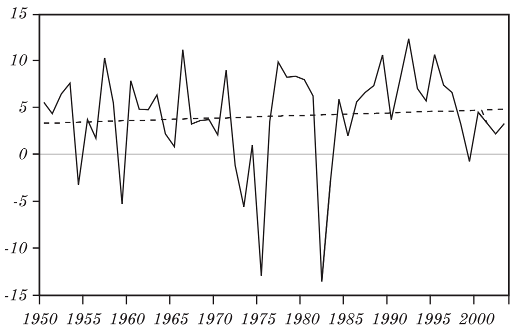
Recessions were not uncommon during the period covered by our sample (1950–2003). The sample includes six periods of negative growth: two in the 1950s (1954 and 1959), three between the early 1970s and early 1980s (1972–73, 1975, and 1982–83) and only one in the late 1990s (1999). The relatively moderate recessions of the 1950s are associated with important domestic economic policy events. The recession of 1954 came about after the very large monetary expansion at the beginning of the Ibañez administration (1952–58), which led to a surge in inflation and a subsequent stabilization program under the Klein-Sacks mission.[3] Price stability was not achieved, however.

2. Observed fluctuations in the annual growth rate were as large as 24 percent (for example, from –13.6 percent in 1982 to 10.6 percent in 1989).

3. Ffrench-Davis (1973) and Zahler and others (1978) contain detailed discussions of the economic policies applied in Chile in the 1950s and 1960s.

The Alessandri administration (1958–64) tried to use the exchange rate to control inflation, but these efforts ended in a second recession in 1959, when the fixed parity of the Chilean currency against the U.S. dollar collapsed.[4] After that period, the economy underwent slowdowns in activity, but no other recession took place until the early 1970s.[5]

Figure 1. Chile's Annual GDP Growth, 1950–2003



Source: See table 2 and section 2 for details.

The recessions of the 1970s and 1980s were more frequent and much deeper than those of the 1950s, and they included a full-blown economic and financial crisis. The 1972–73 recession resulted from the deep social and political crisis of the Allende administration (1970–73), which ended with a military coup and seventeen years of authoritarian rule.[6] The 1975–76 recession was triggered by a sharp deterioration in external conditions, particularly of the terms of trade, in a period with very limited access to external financing owing to the recent political turmoil of the early 1970s. This recession was followed by a period of rapid growth, which ended suddenly with the deep and prolonged recession of 1982–83—the second of the Pinochet regime (1973–90) and the worst in the period under analysis. This recession resulted from a sudden stop in capital inflows that forced the reversal of the (unsustainable) current account deficit. As the

4. The Chilean currency in that period was the escudo.
5. The period 1964–70 corresponds to the Frei Montalva administration.
6. Edwards and Cox Edwards (1987) provide a complete discussion of the policies of the Allende administration and the economic reforms of the Pinochet regime.

terms of trade deteriorated and the international real interest rates peaked, the adjustment required a sharp real exchange rate depreciation. The vulnerabilities of the banking system aggravated the recession. The very rapid increase in bank credit in the late 1970s and early 1980s—largely associated with foreign currency loans and connected lending—resulted in a severe deterioration of the loan portfolio and very high exposure to exchange rate risk. Although the fiscal balance was in surplus and public debt was nil, the peso came under severe market pressures that precipitated the second collapse of a fixed parity in the last fifty years of Chilean economic history. Notwithstanding the economywide crisis, a default on external debt was avoided largely thanks to the initial low level of public debt.

The only recession of the 1990s was the short-lived and quite mild one of 1999. This may reflect the increased resilience built through years of significant reforms and institutional changes, including the contributions of a solid banking system and a coherent macroeconomic policy framework.[7] The 1998–99 episode, like those of 1975 and 1982, featured a sharp deterioration in external conditions that required a reversal in the current account deficit, though at a much more moderate level. The private sector reacted by reducing domestic demand and adjusting asset portfolios to increase net foreign asset holdings. The latter, together with the sharp contraction in the supply of external financing, exerted strong pressures on the exchange rate. The recession might possibly have been avoided if monetary policy had not overreacted by narrowing the exchange rate band to limit currency depreciation.[8] The monetary authority feared that the currency depreciation could lead to an acceleration of inflation above the target and to financial system distress associated with the foreign currency exposures. Thus, domestic real interest rates reached extraordinarily high levels, and economic activity dipped. The overreaction became evident the following year, when inflation fell below the floor of the target range while the financial system did not experience substantial problems. The move was rapidly corrected, however, as the exchange rate was allowed to float in the last quarter of 1999 and interest rates entered a prolonged phase of sustained reductions that were instrumental for the recovery.

7. The prolonged slowdown of the economy that followed the downturn, which is only recently coming to an end, has mirrored the unsupportive external environment that prevailed until recently.

8. See Le Fort (2000).

Most observers of the Chilean economy are of the view that the economy's outstanding performance in the 1990s can be explained in terms of the reforms and stabilization process that began in the 1970s and continued through most of the 1980s and the 1990s. The legitimacy offered by a peaceful transition to democracy, continued opening up of the economy, further development of domestic financial markets (including deeper integration with international financial markets), and a significant strengthening of the macroeconomic policy framework (including fiscal consolidation and successful price stabilization) are all considered key factors. In the late 1990s, the fiscal authorities adopted a self-imposed rule that targets a structural surplus of 1 percent of GDP while allowing the automatic stabilizers to operate throughout the cycle. Moreover, the Central Bank was given full operational and administrative independence in the early 1990s, and its Board of Directors adopted an inflation targeting regime that has been improved over the years. Given the currently supportive external environment, and the strength of its policy framework and institutional arrangements, Chile is very well positioned to quickly return to faster medium-term growth.

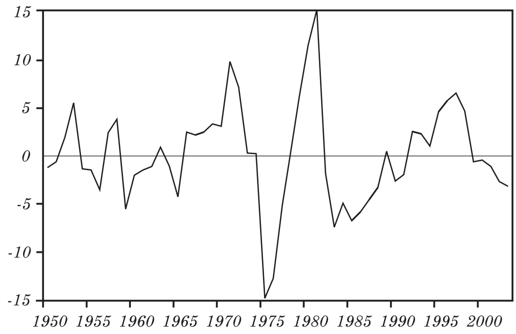
1.1 GDP Cycles

In this paper, we measure the Chilean business cycle over the last half century as the deviations of GDP from its long-term trend, using a Hodrick-Prescott (HP) filter (see Hodrick and Prescott, 1997). As shown in figure 2, the evolution of the output gap over the sample period is anything but monotonous, with marked fluctuations and changing patterns. Cycles can be dated in a number of ways, which can deliver different results in terms of identifying specific cycles. The approach followed herein identifies eight different cycles, as presented in table 1.[9] The average length of the cycle—which includes a low and a high phase—is seven years. One clear pattern is that the cycles were much shorter before the mid-1960s than after (around five years on average). The amplitude of the cycles also increased over time, reaching a maximum in the fifth and sixth cycles (1969–76 and 1976–84) and then declining substantially in the last two cycles.

In the 1950s and 1960s the economy was fairly closed to the rest of the world, with external demand conditions displaying very

9. The discussion in Cashin and McDermott (2004) is illustrative in terms of how cycle dating depends on a set of self-imposed rules, the series over which those rules are applied, and the starting point of the sample, among other things. The cycle dating of table 1 closely follows one set of rules contained in that paper.

Figure 2. Chile's GDP Gap with HP Filter, 1950–2003



Source: See table 2 and section 2 for details.

Table 1. Chile's GDP Cycles, 1950–2003

Period	*Duration*	*Maximum gap*	*Minimum gap*	*Volatility*
1950–55	5.5	5.6	–1.5	2.8
1955–58	4.0	3.8	–3.5	3.9
1958–64	6.0	0.9	–5.6	2.1
1964–69	5.0	3.4	–4.2	3.1
1969–76	7.0	9.8	–14.8	9.4
1976–84	8.0	15.2	–7.4	8.3
1984–90	6.0	0.5	–6.8	2.6
1990–04	14.5	6.6	–3.2	3.3
Average	7.0	5.7	–5.9	4.4

Source: See table 2 and section 2 for details.

low correlation with the Chilean business cycle. The economy was thus rather insulated despite the relatively unfavorable external demand and terms of trade, with an output gap that was close to zero, on average, and with relatively low volatility. The volatility of the output gap increased substantially between the 1970s and 1980s—along with the magnitude of the cyclical changes—and the average output gap was negative. Most of the other variables also display their highest volatility in this period, including external demand conditions, terms of trade, net capital flows, growth in real balances, and fiscal expenditure. As we show in section 4, however, the volatility of the output gap relative to that of international conditions as a whole increased substantially during this period. Finally, in the 1990s, the output gap was positive, on average, and its volatility moderated significantly.

2. Methodological Approach

The data used in this paper are of annual frequency and cover the period 1950–2003. Our empirical model includes twelve variables, derived from both international and domestic series. International series are used to construct five variables intended to measure real and financial external shocks. Domestic variables include a proxy for the Chilean business cycle (namely, the GDP gap, which is our main object of interest), a group of five variables that control for domestic policy shocks, and a variable that captures domestically driven financial shocks.

Most of variables are measured in terms of gaps, that is, deviations from the long-term trend calculated through a Hodrick-Prescott filter.[10] Our first variable is a proxy for the external demand conditions relevant to the Chilean economy, and it is constructed from sectoral indices of World Merchandise Export Volume published by the World Trade Organization (WTO).[11] We use the sectoral share of Chilean exports to aggregate these indices into a single index that captures the dynamism of the external demand for Chilean products. As with most domestic series, our source for constructing the sectoral share of Chilean exports is Braun and others (2000), which contains many series for the Chilean economy during the 1810–1995 period.[12] We extended the export shares series through 2003 using data from the Central Bank of Chile. We used this same combination of sources to obtain the terms of trade, which represents the other real external shock in our empirical model.[13]

10. To prevent the typical tail problems common to this type of filtering process, we use data of up to five years prior to 1950, when available. We also use forecasts of up to two years for variables that are included in gaps, based on official forecasts when available. These extra observations are then dropped.

11. The sectoral indices include agricultural products, mining products, and manufactures. See WTO Statistical data sets at www.wto.org/english/res_e/statis_e/statis_e.htm.

12. The publication is part of a series of documents that includes Jeftánovic, Jofré, and Lüders, (2000) and Jeftánovic and others (2003), which compile statistics covering a long time span for a large set of variables for the Chilean economy.

13. In an alternative specification of the model, the terms of trade is replaced by two variables: the real price of oil and copper (source: IMF).

The other three external variables measure financial shocks faced by the Chilean economy. First, the foreign real interest rate corresponds to the average secondary market rate of the three-month U.S. Treasury bill minus the annual consumer price index (CPI) inflation of the U.S. economy, based on data from the International Monetary Fund (IMF). Second, we include a foreign equity variable as a proxy for the uncertainty of international financial markets. We construct this variable by taking the annual standard deviation of daily real returns from the Dow Jones index (source: New York Stock Exchange). Third, net capital inflows to the Chilean Economy as a percentage of GDP is calculated as the current account deficit net of international reserves accumulation over GDP through 1988 (Braun and others, 2000); thereafter, it is taken directly from the Central Bank of Chile's balance-of-payments statistics.

Most domestic variables are related to policy shocks. The first one—the de facto openness of the Chilean economy, measured as the share of exports and imports in GDP—is constructed through 1987 as the sum of export and imports in Chilean pesos (from Jeftánovic, Jofré, and Lüders, 2000), deflated by the Chilean CPI (from Jeftánovic and others, 2003) and divided by real GDP (from Braun and others, 2000); data after 1989 are from Central Bank of Chile's balance-of-payments statistics. The second variable—the real growth of money—is taken from the Central Bank of Chile's monetary and financial statistics, available since 1960, and complemented with Jeftánovic and others (2003) for the previous period. We use two variables as proxies for fiscal policy—namely, the real growth of fiscal revenue and fiscal expenditure. These two variables are taken from Jeftánovic, Jofré, and Lüders (2000) through 1986 and from the Budget Office of the Chilean Ministry of Finance (DIPRES) thereafter. Finally the real exchange rate is taken from Jeftánovic and others (2003) through 1989 and from the Central Bank of Chile thereafter.

We also include domestic equity to capture business confidence. This variable is constructed as the real returns of the stock index (IPSA), which are taken from Braun and others (2000) through 1969 and from the Santiago Stock Exchange thereafter.

Finally, our main variable of interest is the business cycle, which we construct from data on real GDP taken from Braun and others (2000) through 1995 and the Central Bank of Chile thereafter. Table 2 summarizes the twelve variables included in our empirical model, and table 3 presents descriptive statistics.

Table 2. List of Variables

Variable	*Type*	*Definition*	*Source*
External demand	External/real	Deviation of log from HP trend	WTO; Braun and others (2000); Central Bank of Chile
Terms of trade	External/real	Deviation of log from HP trend	Braun and others (2000); Central Bank of Chile
Foreign interest rate	External/financial	Deviation of real rate or return from HP trend	IMF
Foreign equity	External/financial	Deviation of standard deviation of real returns from HP trend; annual standard deviation calculated from daily data	NYSE
Net capital inflows	External/financial	Deviation of ratio over GDP from HP trend	Braun and others (2000); Central Bank of Chile
Openness	Domestic/policy	Ratio over GDP	Jeftánovic; Jofré; and Lüders (2000); Jeftánovic and others (2003); Braun and others (2000); Central Bank of Chile
Real exchange rate	Domestic/policy	Deviation of log from HP trend	Jeftánovic and others (2003); Central Bank of Chile
Money	Domestic/policy	Real growth rate	Jeftánovic and others (2003); Central Bank of Chile
Fiscal revenue	Domestic/policy	Real growth rate	Jeftánovic; Jofré; and Lüders (2000); DIPRES
Fiscal expenditure	Domestic/policy	Real growth rate	Jeftánovic; Jofré; and Lüders (2000); DIPRES
Domestic equity	Domestic/financial	Deviation of real rate or return from HP trend	Braun and others (2000); Central Bank of Chile
Output	Main variable of interest	Deviation of log from HP trend	Braun and others (2000); Central Bank of Chile

Table 3. Descriptive Statistics of Variables

Variable	*External demand*	*Foreign interest rate*	*Foreign equity*	*Terms of trade*	*Oil price*	*Copper price*	*Openness*	*Net capital flows*	*Real exchange rate*	*Domestic equity*	*Output*	*Money*	*Fiscal revenue*	*Fiscal expend.*
Average per period														
1950–69	–0.8	0.1	0.0	0.7	0.0	–1.0	22.1	0.1	2.4	3.0	0.1	2.1	7.0	6.8
1970–90	0.6	0.0	0.4	0.2	0.4	1.3	32.3	–0.2	–0.8	–3.0	–0.7	7.6	2.7	3.4
1991–03	0.3	–0.2	–0.2	–1.0	–1.2	–3.9	44.7	0.1	–1.5	1.0	1.4	9.6	6.3	6.9
1950–2003	0.0	0.0	0.1	0.1	–0.2	–0.8	31.5	0.0	0.2	0.2	0.1	6.1	5.2	5.5
Standard deviation per period														
1950–69	4.9	1.7	3.4	11.6	8.4	11.9	5.6	1.0	13.1	21.1	2.9	14.8	13.3	8.8
1970–90	6.4	1.6	4.7	14.1	28.5	17.6	11.7	3.3	24.7	30.6	7.6	22.9	8.7	14.6
1991–03	2.3	1.2	3.3	5.6	16.0	15.3	3.9	2.4	7.3	36.0	3.3	6.6	5.6	3.1
1950–2003	5.1	1.5	3.9	11.4	19.8	15.0	12.0	2.4	17.5	28.5	5.3	17.2	10.2	10.6
Correlation coefficient of variable against output gap per period														
1950–69	0.1	–0.2	0.2	0.2	–0.4	–0.3	0.3	0.1	0.6	0.5	1.0	0.1	–0.2	–0.1
1970–90	0.5	0.0	–0.3	0.4	0.1	0.3	–0.2	0.5	–0.4	0.3	1.0	0.4	0.1	0.4
1991–03	0.5	0.5	–0.4	0.3	–0.3	0.5	–0.6	0.3	–0.8	–0.6	1.0	–0.2	0.1	0.2
1950–2003	0.4	0.0	–0.2	0.3	0.0	0.2	0.0	0.4	–0.3	0.1	1.0	0.3	0.1	0.3

Source: See table 2 and section 2 for details.

2.1 Specification

We use a VAR model of the Chilean economy that contains twelve equations corresponding to each of the variables described above. We use Choleski decomposition and impose block exogeneity restrictions consistent with the fact that the Chilean economy is a small open economy, meaning that domestically determined variables cannot affect the international block. Based on this approach—which let us reduce the overall number of parameters estimated for most equations—and our relatively large annual sample, we were able to estimate a VAR with such a large number of endogenous variables. Moreover, the dynamic structure of this model based on annual data is adequately handled by including only one lag.[14] The block exogeneity extension for small open economies was first used by Cushman and Zha (1997) for the Canadian economy. More recently, Dungey and Pagan (2000), Hoffmaister and Roldós (2001), and Buckle and others (2002) use a similar approach in applications for Australia, Brazil and Korea, and New Zealand, respectively.

The equations in our model are thus arranged in a way that takes into account the fact that a Choleski decomposition identification scheme depends theoretically on the order of the equations, with the lag structure of the model consistent with the small open economy case.[15] Table 4 summarizes the order of the equations and the lag structure of the model.

Most of the equations for variables pertaining to the international block precede the equations for variables pertaining to the domestic block. Thus, the first three international variables—external demand conditions, foreign interest rate, and uncertainty in international financial markets—are completely exogenous to the other variables included in the model, but they are interrelated with each other. That differs from the case of the terms of trade, which is affected (only) by the previous three variables but does not affect them.[16] The final variable

14. This is unlikely to be the case for a model based on data with quarterly frequency, which presumably may require four lags. The latter feature—together with the fact that quarterly data for most of the series that we use in this model are available only since 1986 and in some cases only since the early 1990s—prevents the estimation of a VAR with a large set of endogenous variables based on quarterly data for Chile.

15. We considered a number of different orderings and found no apparent changes in the results. This suggests that the structure of our lag restrictions considerably limits the ordering problem with respect to a nonrestricted (Choleski) VAR.

16. In the alternative specification in which terms of trade is replaced by both oil and copper prices, the oil price is allowed to affect external demand conditions, the foreign interest rate, and uncertainty in international financial markets, and vice versa.

Table 4. Order of Equations and Lag Structure of the Model

Dependent variable	*Independent variable*: *External demand*	*Foreign interest rate*	*Foreign equity*	*Terms of trade*	*Net capital flows*	*Openness*	*Output*	*Money*	*Fiscal revenue*	*Fiscal expend.*	*Real exchange rate*	*Domestic equity*
External demand												
Foreign interest rate												
Foreign equity												
Terms of trade												
Net capital flows												
Openness												
Output												
Money												
Fiscal revenue												
Fiscal expend.												
Real exchange rate												
Domestic equity												

of the international block, net capital inflows to the Chilean economy, features no lag restrictions, since it could potentially be affected by all the variables included in the model. We allow it to be contemporaneously affected by the four international variables that precede it in terms of the order of the equations. The lag structure of the equation associated with a measure of trade openness (a medium-term domestic policy decision) only depends on the lag for itself.[17]

The equation that accounts for monetary policy is assumed to depend on the lag of itself, the foreign real interest rate, capital inflows, the real exchange rate, and the two fiscal policy variables (namely, fiscal revenue and fiscal expenditure). Fiscal revenue is assumed to depend on the lag of itself, the terms of trade, and the output gap, while fiscal expenditure is assumed to depend on the lags of itself, output, and fiscal revenue. The other equations in the domestic block are those associated with the real exchange rate, domestic stock returns, and the business cycle. These equations feature no lag restrictions, the first two because they represent domestic asset prices and the third because we do not want to restrict the relationships of our main object of interest (that is, the business cycle).

This VAR specification satisfies the stability condition, as all the eigenvalues lie inside the unit circle, and the evidence presented in the following sections is robust to several changes. First, using different orderings to identify the orthogonal shocks does not qualitatively change the paper's results. The only evident difference resulted when we shifted output below domestic policy conditions: all impulse response functions looked relatively similar, but the contribution of monetary policy to business cycle fluctuations was significantly lower in this case, with almost all the effect captured by domestic equity. Second, the results are also robust to reducing or expanding the variables included in the model.[18] For example, we eliminated capital inflows, so as to leave the whole group of external variables completely block exogenous.[19] In this

17. Trade openness is presumably correlated with all the external variables, including net capital flows, contemporaneously.

18. All these estimates are available on request.

19. It was suggested to us that the two external financial variables already included in the model (namely, foreign interest rate and international capital market uncertainty) might be enough to capture changes in external financing conditions to the Chilean economy. The evidence, however, pointed toward an independent effect of capital inflows. To capture such an effect in a more exogenous way, net capital inflows to Argentina, Brazil, and Mexico as a percentage of their combined GDP were included instead of net capital inflows to the Chilean economy. This variable turned out to be statistically insignificant, suggesting that the common factor between capital inflows to the most important Latin American economies and capital inflows to Chile is not very relevant.

case, most of the effect was captured by a higher persistency of the output gap. We also tried expanding the model by replacing the terms of trade with two separate variables—namely, the real prices of oil and copper. Again, results were qualitatively similar regarding the relationship between the other variables and the business cycle. We also included a dummy variable to capture natural catastrophes (both earthquakes and climatic conditions), given Chile's geographical characteristics. Contrary to our expectations, domestic output did not display a statistically significant response to a positive innovation in this natural catastrophes dummy variable, and all the other variables maintained their impact and significance.[20]

3. Macroeconomic Responses and Sources of Fluctuations

This section presents the results of our VAR exercise, using impulse response functions and variance decomposition analysis to illustrate the effects and persistence of shocks on the different variables of the empirical model. We start by describing the economy's responses to the five external shocks identified above, including two foreign real shocks (external demand and terms of trade) and three foreign financial shocks (foreign interest rate, foreign equity, and net capital flows). We then address domestic shocks, covering five domestic policy shocks (monetary policy, two fiscal policy measures, real exchange rate, and openness) and a domestic equity shock. At the end of this section, we report our results regarding the sources of business cycle fluctuations.

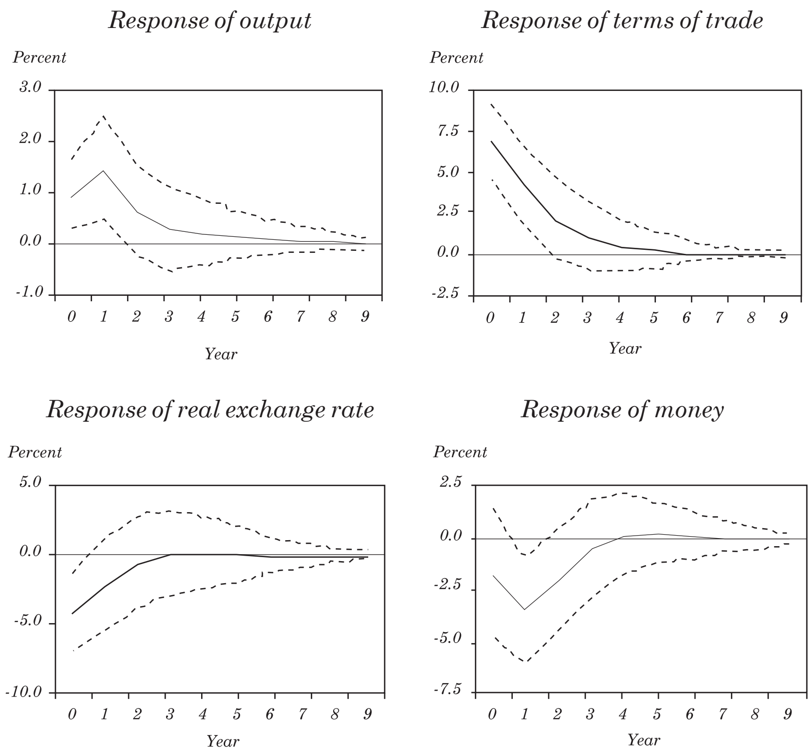
3.1 External Shocks

Figure 3 shows responses to a positive innovation to external demand. Chilean output expands on impact with a lasting effect of around two years. The peak response occurs in the first year. The

20. Earthquakes and sustained droughts were represented by a dummy variable. Droughts were considered if the cumulative shortfall from normal rainfall accumulated over the last four years exceeded 308 millimeters per year (which corresponds to the sample average rainfall minus 10 percent of the sample standard deviation). Following this definition, drought years are 1969, 1970, 1971, 1976, and 1996. Annual data on total rainfall was obtained from Dirección Metereológica de Chile (2003). Similarly, only earthquakes with a magnitude above 7.0 on the Richter scale that occurred less than 50 kilometers from the surface were considered as a natural disaster with macroeconomic relevance. Following this definition, earthquake years are 1960, 1971, 1975, 1985, and 1995 (Servicio Sismológico, 2003).

external demand shock is also transmitted immediately into the real exchange rate and the terms of trade, in different directions. In particular, the appreciation of the real exchange rate and its negative effects on output do not offset the positive effect that is generated with better terms of trade. Economic activity then begins to drop off in response to tighter monetary policy as the economy starts to expand.

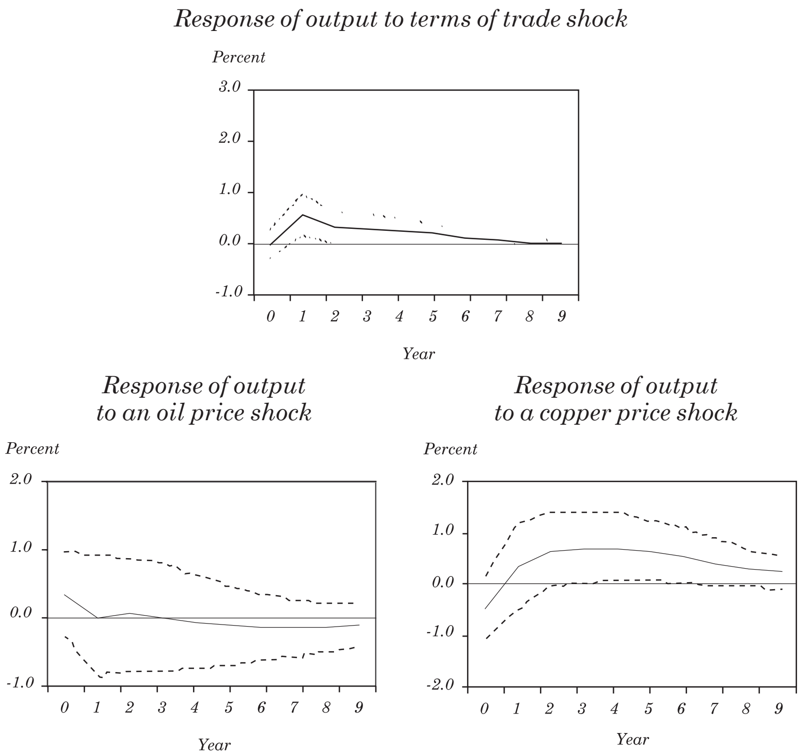
Figure 3. Response to an External Demand Shock



Responses to a rise in the terms of trade are consistent with conventional wisdom (see figure 4). In particular, an improvement in the terms of trade implies a positive impact on the business cycle. The effect on domestic output appears to be higher from the first year on, with a lasting effect of five years even when the persistence of the terms-of-trade shock is only two years. A terms-of-trade shock could stem from a rise in the price of exports or a fall in the price of imports.

Emphasis is usually placed on copper and oil prices in the case of Chile. An alternative VAR that includes these prices instead of the terms of trade shows that both shocks have the expected effects on the business cycle, but their respective impulse-response functions are not statistically significant. This suggests that the dominant source for explaining business cycle fluctuations is a composite of export and import prices, and not copper and oil prices alone. The public discussion of the significant impact of copper prices on the business cycle may thus be overstated.

Figure 4. Response to a Different Terms-of-Trade Indicator Shock



The responses to a rise in the foreign interest rate are illustrated in figure 5. This shock is transmitted into lower monetary aggregates in the first year. The corresponding increase in the domestic interest rate translates into a lower demand for domestic equities, reducing real returns immediately. Consequently, domestic output eventually falls in response to monetary policy tightening and the reduction in equities.

Figure 5. Response to a Foreign Interest Rate Shock

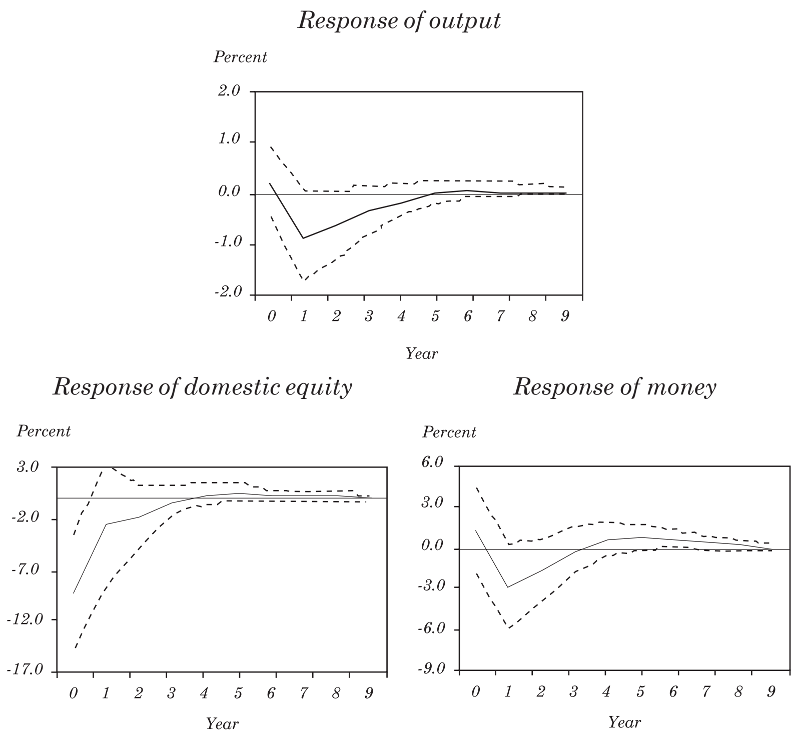
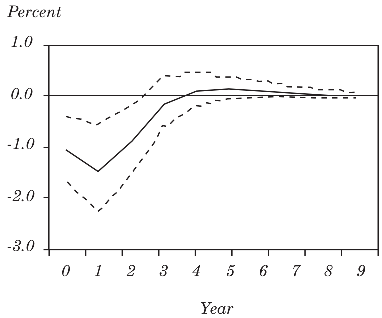


Figure 6 shows that an increase in the volatility of world equities causes a negative impact on the real return of Chilean equities and a decline in capital flows. This may reflect higher external financing costs that could have an impact on the risk premium associated with emerging markets. The combination of these negative forces has an immediate negative effect on the business cycle that lasts two to three years.

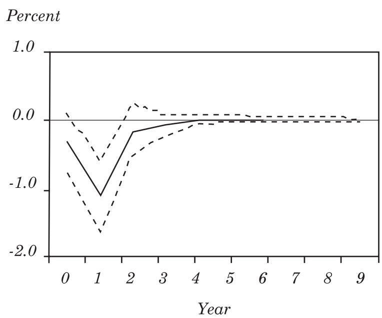
Finally, an increase in net capital flows leads, as expected, to an expansion of the business cycle on impact, which lasts one year (see figure 7). This reflects the financial restrictions faced by an emerging economy like Chile, in the sense that these restrictions imply that the ups and downs of net capital flows have a significant impact on the cyclical behavior of the economy.

Figure 6. Response to a Foreign Equity Shock

Response of output



Response of net capital flows



Response of domestic equity

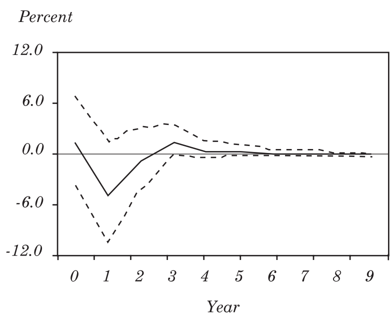
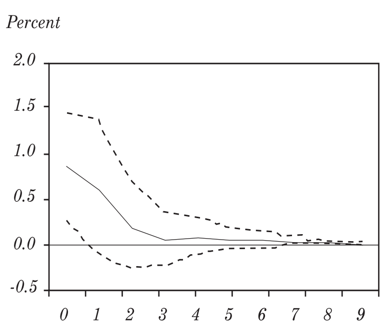
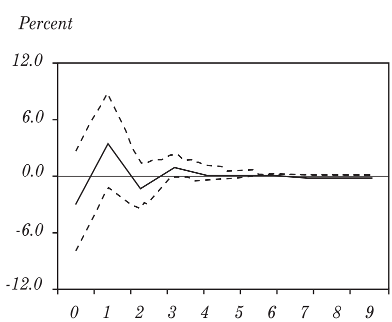


Figure 7. Response to a Net Capital Flow Shock

Response of output



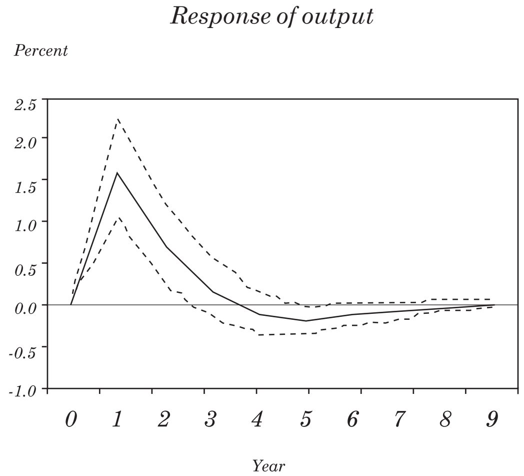
Response of domestic equity



3.2 Domestic Shocks

Figure 8 tracks the responses to a monetary policy shock. After an expansionary monetary policy shock, the impulse-response function for the business cycle displays a hump-shaped pattern, with the peak effect in the first year and a significant persistence of two years.

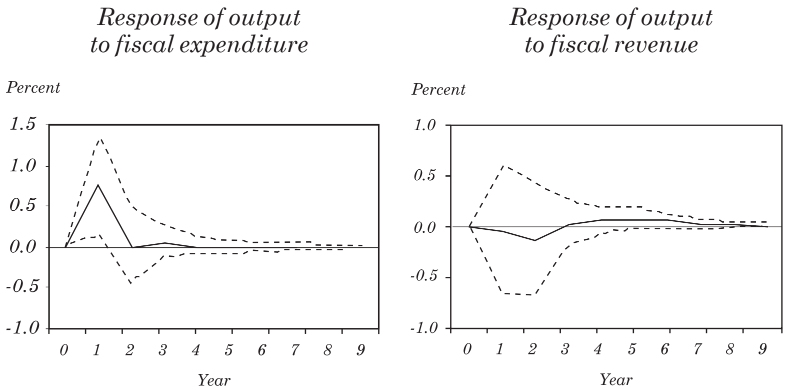
Figure 8. Response to a Monetary Policy Shock



With regard to fiscal policy shocks, the first issue to be resolved in an empirical study is what indicator to use as a measure of policy stance. The usual candidate for this role is the fiscal deficit, but this measure has several well-known problems that make it a weak indicator of discretionary fiscal policy. The fiscal deficit captures both exogenous policy shifts and the automatic reaction of fiscal variables to the state of the economy. Even when changes in the deficit reflect purely discretionary policy decisions, the source of the change—whether a revenue adjustment or a change in government spending—is obviously important for the expected response of the private sector. Consequently, we consider the effects of expenditure and revenue separately. Fiscal expenditures have a high component of policy discretion, while fiscal revenues are explained not only by fluctuations in the tax regime, but also by endogenous reactions following changes in economic activity.

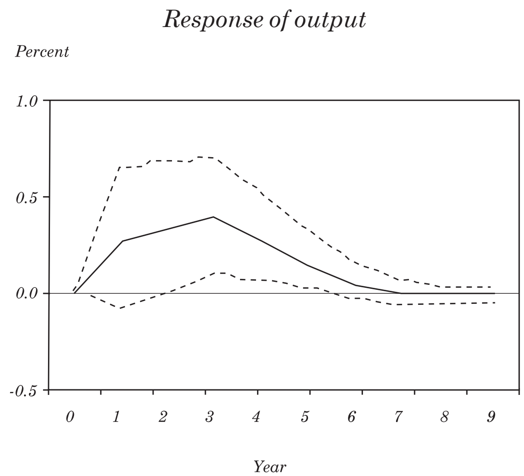
Figure 9 shows the responses to positive innovations to fiscal expenditure and revenue. The response of the business cycle is expansionary and statistically significant in the case of government spending, but not in the case of fiscal revenue. This suggests that domestic demand is relatively unresponsive to changes in fiscal revenues.

Figure 9. Response to a Fiscal Policy Shock



A real exchange rate shock has a positive impact on the Chilean business cycle, as shown in figure 10. The impact on output takes two years to become significant, however, and it then lasts for another two years.[21]

Figure 10. Response to a Real Exchange Rate Shock

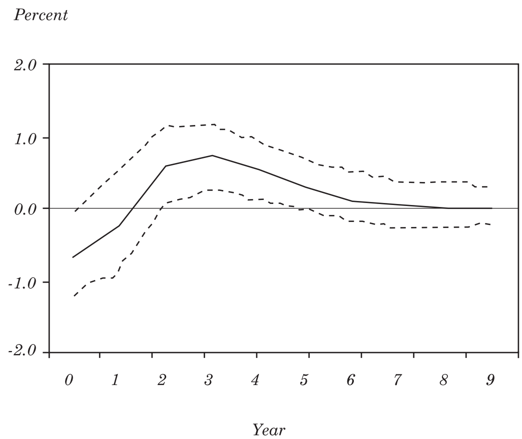


21. An increase in the real exchange rate represents a real depreciation of the Chilean peso.

Figure 11 shows that the business cycle reacts positively—but with a lag of three years and a lasting effect of two years—to an increase in the openness of the economy. Since we use de facto openness, the variable reflects a combination of policy decisions and endogenous reactions. If we assume that the trajectory of the variable is influenced mostly by policy, greater openness appears to have helped moderate the impact of external shocks.

Figure 11. Response to an Openness Shock

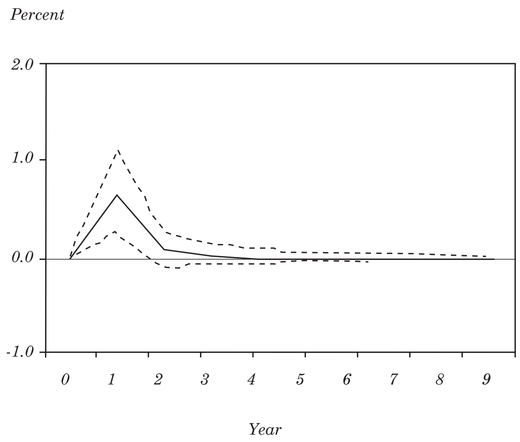
Response of output



Finally, figure 12 illustrates the responses to a positive innovation to domestic equity returns. This domestic financial shock has a positive impact in the business cycle in the first year, but the effect vanishes thereafter.

Figure 12. Response to a Domestic Equity Shock

Response of output



3.3 Sources of Business Cycle Fluctuations

We carried out a variance decomposition analysis to determine what fraction of the variance of the Chilean business cycle is attributable to each shock (see table 5). The results can be summarized in three main findings. First, foreign shocks have a substantial effect on business cycle volatility, with external demand and foreign equity (volatility) shocks representing the dominant source of domestic output fluctuations.[22] Foreign shocks represent 28 percent of business cycle fluctuations in the first year, reaching 42 percent in the third year. Second, domestic equity shocks and fiscal policy shocks have relatively little impact on the business cycle, whereas trade openness and the terms of trade explain a much larger fraction of business cycle fluctuations. Finally, monetary policy shocks play an important role in explaining the forecasting error variance of the business cycle.

22. In one of the most recent assessments using a VAR model, Buckle and others (2002) reach a similar conclusion in which international variables—particularly world output, world equity prices, and world interest rates—are the key sources of volatility in New Zealand's real GDP. Similarly, Parrado (2003), in an empirical work that identifies the geographical sources of external shocks that have influenced the New Zealand business cycle, finds that volatility in Australian interest rates and U.S. equity prices are important sources of business cycle fluctuations.

Table 5. Chilean Business Cycle Variance Decomposition

Step	*Standard error*	*External demand*	*Foreign interest rate*	*Foreign equity*	*Terms of trade*	*Net capital flows*	*Openness*	*Output*	*Money*	*Fiscal revenues*	*Fiscal expenditures*	*Real exchange rate*	*Domestic equity*
0	0.029	9.29	0.51	10.88	0.05	7.44	4.43	67.40	0.00	0.00	0.00	0.00	0.00
1	0.044	13.65	3.57	14.21	5.74	4.86	2.16	39.57	11.46	0.02	2.50	0.33	1.95
2	0.047	13.57	4.68	15.43	6.47	4.38	3.33	35.69	11.78	0.10	2.18	0.68	1.71
3	0.048	13.26	4.96	14.77	7.41	4.18	4.96	34.09	11.32	0.10	2.09	1.23	1.63
4	0.049	13.07	4.89	14.42	8.23	4.10	5.83	33.18	11.08	0.10	2.03	1.49	1.59
5	0.049	13.00	4.82	14.30	8.65	4.06	6.08	32.77	11.07	0.11	2.01	1.55	1.57
6	0.049	12.99	4.81	14.27	8.80	4.05	6.12	32.63	11.10	0.11	2.00	1.55	1.56

Source: Authors' calculations.

4. Shock Resilience of the Chilean Economy

The variance decomposition analysis presented in the previous section confirms the common wisdom that fluctuations in the Chilean business cycle are largely explained by external shocks. The prominence of external shocks is due to the country's condition of being a small open economy—open to both trade and financial flows—with an export structure that is not sufficiently diversified and with limited access to international financing. Indeed, external shocks explain more than twice as much of the business cycle fluctuations as domestic shocks. In this section, we undertake a historical decomposition analysis to explore the volatility and resilience of the Chilean economy and its correlation and synchronization with international shocks.[23]

4.1 Historical Decomposition

In analyzing the effects of different combinations of shocks on output, including how the output response to those shocks has evolved over time, we divide business cycle fluctuations into different components: international conditions, policy conditions, other domestic shocks, and a remainder that includes the inertial or lagged effect and the error term (that is, other shocks that we do not control for). Then, we assess how the importance of these different components has evolved over time and whether domestic policies have contributed to moderating the effects of international shocks. The latter would suggest that the economy's resilience to external shocks has increased.[24]

23. We decompose the historical values of a set of time series into a basis projection and the accumulated effects of current and past innovations. This decomposition allows us to observe whether movements in the business cycle were likely the result of a combination of innovations or of a specific variable. The historical decomposition is based on the following partition of the moving average representation:

$$y_{t+j} = \sum_{s=0}^{j-1} \Psi_s u_{t+j-s} + \left(X_{t+j}\beta + \sum_{s=j}^{\infty} \Psi_s u_{t+j-s} \right),$$

where the first summation represents that part of y_{t+j} due to innovations in periods $t + 1$ to $t + j$ and where the second part is the forecast of y_{t+j} based on information available at time t. If u has n components, the historical decomposition of y_{t+j} has $n + 1$ parts: the forecast based on information at time t (the term in parentheses); and, for each of the n components of u, the part of the first term that is due to the time path of that component.

24. Data limitations prevent us from using a more straightforward approach to this issue—namely, the estimation of separate VARs within two subsamples, which would amount to looking for evidence of a structural break in the response of output to international conditions, policies, or other domestic shocks.

Figures 13 and 14 show the business cycle fluctuations divided by the different components described above. The international conditions component includes external shocks—both real (external demand and terms of trade) and financial (foreign interest rate, volatility of international financial markets, and net capital flows). The policy conditions component encompasses the effects of changes in monetary and fiscal policy (from both the revenue and expenditure sides) and the effects of changes in structural policies, captured by the degree of openness to international trade and the real exchange rate.[25] Finally, other domestic conditions refer to the effect of changes in domestic stock market prices that are beyond the medium-term average return.

Figure 13. GDP Cycle and Components

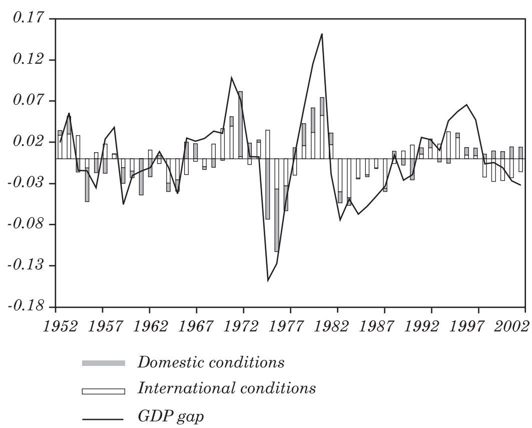


Figure 13 shows that cyclical output fluctuations are mainly explained by international and policy components, while the effect of other domestic shocks appear to be much smaller. The remainder component (lagged output and an error term) also plays an important role, primarily because of the autocorrelation of the output cycle.

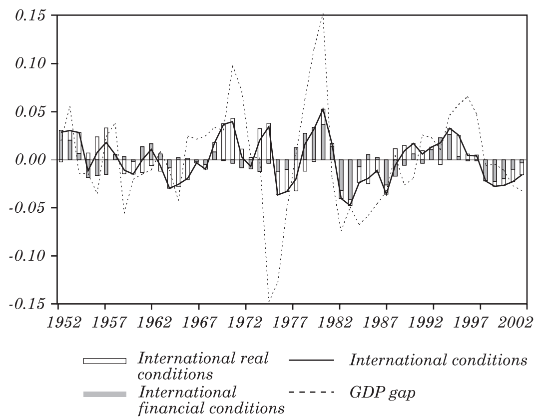
Real and financial international conditions appear to make similar contributions to the cyclical fluctuations of output (see figure 14). The total effect of international conditions on the output cycle does not show significant changes in terms of magnitude across the sample. This is

25. We consider this variable a structural policy because the fact that the Chilean economy was characterized by different exchange rate regimes over the sample period implies that the adjustment process followed by this relative price changed over time as a result of exchange rate policy decisions.

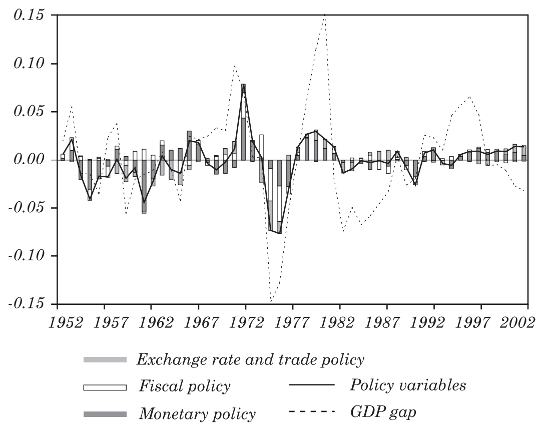
not the case of the policy component, which appears to have had broader effects on the cycle in the first two-thirds of the sample period than in the final period. With regard to policy components, monetary and fiscal policy have larger effects on cyclical output fluctuations than exchange rate and trade policies (structural component).

Figure 14. International Conditions and Policy Conditions

A. International conditions



B. Policy conditions

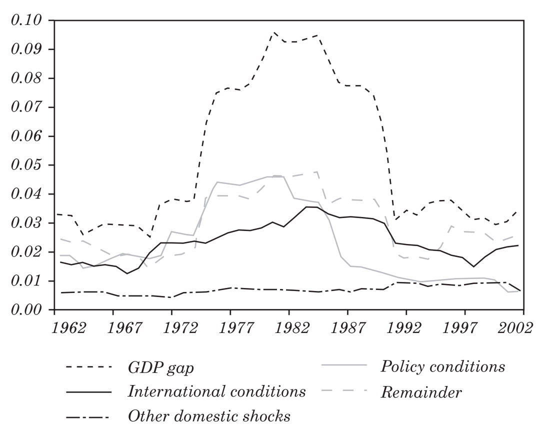


4.2 Volatility and Resilience

Output volatility, measured by the ten-year rolling standard deviation of the output gap, reached peaks in the late 1970s and early 1980s, as shown in figure 15. The differences are such that the gap volatility in peak years was up to three times the level of the calmer years of the 1960s and 1990s. The volatility of some of the components of the output gap also reached sustained peaks that extend from the mid-1970s to the early 1980s, as in the case of policy conditions and the remainder. In the case of international conditions, volatility peaked in the mid-1980s. Other domestic shocks present a relatively stable and low volatility throughout the sample period.

Figure 15. Volatility of GDP Gap and Components

Ten-year rolling standard deviation

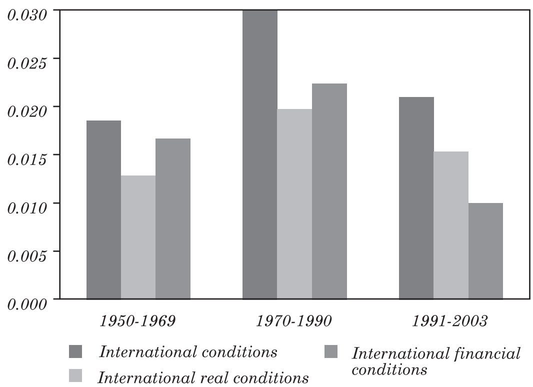


The peak in the GDP gap volatility cannot be associated with a single factor. While the volatility of international conditions increased steadily until the mid-1980s and then declined, the volatility of policy conditions and the remainder also contributed to the peak. Consequently, the increase and subsequent fall of output gap volatility was much more marked than that of any individual component considered on its own.

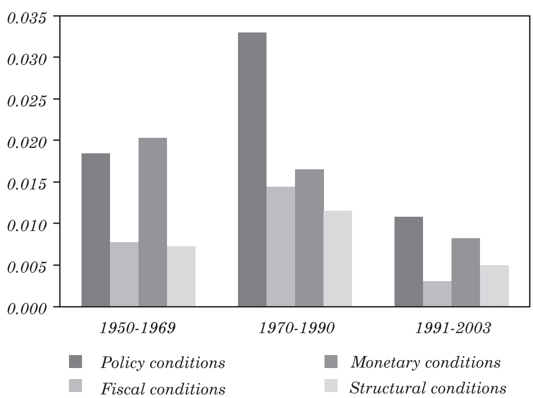
The volatility of international conditions, both as a whole and in its real and financial components, reached a maximum in 1970–90 and then fell sharply in the 1990s (see figure 16). However, the drop in the volatility of external conditions in the last decade of the sample period is not nearly as marked as that of the output gap or policy conditions.

Figure 16. Volatility of Gap Components: International Conditions and Policy Conditions

A. International conditions



B. Policy conditions



The policy conditions component registered the largest reduction in volatility, even larger than the output gap itself. This suggests that demand management and structural policies have made an economically significant contribution toward moderating business cycle fluctuations—in terms of both magnitude and amplitude. This outcome reflects the strengthening of the macroeconomic policy framework and an ongoing process of institutional building. On disaggregating this trend, we find that the volatilities associated with structural and monetary policies fell to about half their previous values, while the volatility of fiscal policy fell much more markedly.

Resilience is commonly defined as the capacity to withstand shocks. It can thus be understood as the economy's capacity to limit the volatility of the output gap when confronting exogenous shocks. To measure resilience to external shocks—the most important type of exogenous shocks faced by the Chilean economy—we compute the ratio of the volatility of external shocks to the volatility of the output gap.[26] As presented in table 6, resilience to external shocks deteriorated markedly in the 1970s and 1980s and then improved sharply in the 1990s, to a slightly higher level than in the 1950s and 1960s. The deterioration in the resilience to external shocks in the 1970s and 1980s was to external shocks of both a financial and a real nature. However, the subsequent recovery of resilience in the 1990s was concentrated on external shocks of a financial nature.

Table 6. Resilience to External Shocks[a]

Period	*Total*	*Financial*	*Real*
1950–69	0.61	0.42	0.55
1970–90	0.40	0.26	0.29
1991–2003	0.63	0.46	0.30

a. Volatility ratios of external conditions against the output gap.

4.3 Correlation and Synchronization

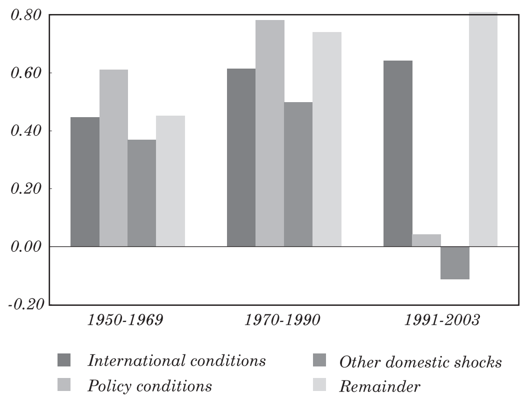
As the economy's integration with the rest of the world deepens, the synchronization of the domestic business cycle with external conditions is expected to increase. The evidence gathered in the previous section, however, suggests that the economy has become more resilient to external shocks. An interpretation that helps reconcile these facts is that policy actions can play a role as shock absorbers. Improved resilience to external shocks may result from policy actions that more effectively stabilize output, which would be manifested, for example, in a shift in the policy component from procyclical (positive correlation with the output gap) to countercyclical (negative correlation).

26. An alternative way to look at resilience is to analyze the contributions of the different components along the cyclical downturn. The results obtained through a preliminary analysis using this approach were qualitatively similar.

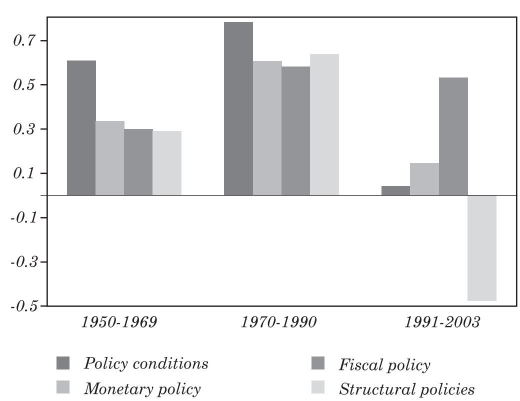
Over time, the Chilean business cycle has become increasingly associated with international conditions. The correlation coefficient increased from 0.45 in the first period (1950–69) to 0.60 in the second (1970–89) and almost 0.65 in the third (1990–2003). In other words, the domestic and external business cycles have indeed become more synchronized (see figure 17).

Figure 17. Correlations of GDP Gap with Main Components and Policy Conditions

A. Main components



B. Policy conditions



In sharp contrast with the pattern of increasing correlations described above, the correlation between policy conditions and the output gap increased only from the 1950s and 1960s to the 1970s and 1980s. It then dropped dramatically to almost zero in the 1990s. In other words, policy actions—which were highly procyclical in the past—played a cyclically neutral role after the early 1990s. A closer look at the correlations of the individual variables contained in the domestic policy component shows that the drop in correlation in the 1990s was widespread, but the shift from procyclicality to countercyclicality is fully captured by structural policies for the period as a whole.

Hence, the continuous trade opening (which allows the trade balance to adjust smoothly to negative external shocks) and the increasingly flexible exchange rate (which enhances the real exchange rate's role as shock absorber) were the main contributors to the increased resilience of the 1990s. Monetary policy also contributed to eliminating procyclical policy conditions in the 1990s. That is not the case, however, for fiscal policy, whose correlation with the business cycle remained stable relative to the 1980s.

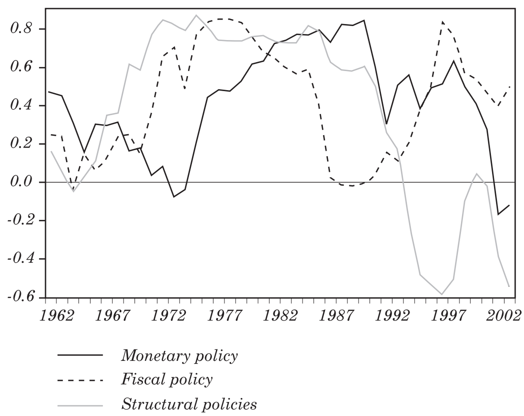
On the whole, the countercyclical role of economic policies became evident only in the 1990–2003 period, but a detailed examination of the timing of the fall in the correlation between domestic policies and the output gap shows a somewhat different pattern (see figure 18). The correlation with fiscal policy started falling in the early 1980s, but it increased again in the mid-1990s, while the correlations with monetary and structural policies started falling in the late 1980s and became negative in the last years in the sample. The process has not been continuous, however, with some reversals associated with significant episodes in policymaking.

The correlation of the output gap and structural policies fell sharply after the widening of the exchange rate band was initiated in 1991, reaching a negative value in the mid-1990s. The correlation increased around 1998, probably in response to the narrowing of the exchange rate band, and it fell again from 1999 onward, after the elimination of the band.

In the late 1980s the correlation between monetary policy and the GDP gap was positive and quite high (0.8). This correlation fell continuously, in the 1990s, as the independent Central Bank developed its inflation targeting framework and gained credibility, although a short interruption occurred in 1998 as a result of the narrowing of the exchange rate band and the hike in interest rates that paved the way to the short-lived recession of 1999. After that, the correlation continued

Figure 18. Correlation of GDP Cycle versus Policy Conditions Components

Ten-year rolling correlation coefficients



to fall, with monetary policy becoming countercyclical in 2002 and 2003. This result reflects the full-fledged inflation targeting framework currently in place and the associated reduction in interest rates over the last four years.[27]

Finally, the correlation of fiscal policy and the output gap fell markedly after the 1982 debt and banking crisis, even reaching negative values toward the latter part of the 1980s. In the second half of the 1980s, a strong economic recovery from the depressed post-crisis conditions took place within the framework of an IMF-supported program, which included an important fiscal consolidation effort. This accounts for the negative correlation between the output gap and the fiscal component. The correlation of fiscal policy and the GDP gap increased again in the 1990s, becoming positive in 1992 and reaching a maximum in 1997 as fiscal policy regained its procyclical characteristics. In this period, a policy of constant nominal fiscal surpluses was pursued. Fiscal expenditures therefore mirrored the cyclical pattern of fiscal revenue, which is largely determined in Chile by private spending given the high share of the VAT in total revenue.

27. The latter has contributed to the recovery from the prolonged economic slowdown that followed the downturn. According to most analysts, the negative output gap is expected to be closed in or around 2005.

At the end of the 1990s, the current administration of President Ricardo Lagos corrected the pro-cyclicality of fiscal policy by adopting a fiscal rule that allows automatic stabilizers to operate fully across the cycle. The operation of this fiscal rule should cause the correlation between the fiscal component and the business cycle to converge toward zero.

Overall, the strengthening of the policy framework in the last period of the sample (including the floating of the exchange rate, the adoption of the fiscal rule, and the refinement of the inflation targeting framework) seem to have played a significant role in the observed increase in the economy's resilience. This bodes well for these positive developments to be sustainable in the future.

5. Concluding Remarks

In this paper, we estimated a VAR model for a small open economy like Chile by introducing block exogeneity into the lag structure of the model. First, to take a relatively long view, we draw on an extended sample dating back to the 1950s. Second, to better capture the characteristics of the Chilean economy, we include an expanded set of variables that let us account for the impact of external shocks (both of real and financial), domestic shocks (including policy variables that capture both demand management and structural policies), and other domestic shocks. We use this toolkit to analyze the associated dynamic responses of the business cycle to several shocks (impulse responses), the sources of business cycle fluctuations (variance decomposition), and the shock resilience of the Chilean economy (historical decomposition).

Several interesting results emerge. First, in terms of the impulse response analysis, real external shocks (domestic demand and terms of trade) have significant effects on domestic economic activity. We provide evidence that the terms of trade, which reflect a composite of export and import prices, captures the dynamic response of the economy better than copper and oil prices alone. Furthermore, financial external shocks are transmitted to the domestic economy through several channels, and they have significant effects on domestic economic activity. The significant impact in the cyclical behavior of the economy following a shock in either the volatility of international financial markets or net capital flows reflects the financial restrictions faced by an emerging economy like Chile. Among domestic policy shocks, demand management policies (represented by monetary policy and government spending) and structural policies (represented by the real exchange rate and trade openness) significantly affect business cycle fluctuations, as is also the case of other domestic shocks such as business confidence (represented by stock returns). In contrast, we did not find evidence to support the belief that natural catastrophes such as droughts and earthquakes have a significant impact on economic activity.

Second, our variance decomposition analysis indicates that foreign shocks have a substantial effect on business cycle volatility. In particular, external demand and foreign equity (volatility) shocks were the dominant source of domestic output fluctuations in the sample period. Other external shocks—in order of importance and at some distance—include the terms of trade, net capital flows, and international interest rates. Among policy variables, monetary policy is the most important source of business cycle fluctuations, with a contribution similar to that of the most important external shocks. Structural and fiscal policy policies explain a relatively low fraction of business cycle fluctuations.

Finally, our historical decomposition analysis provides ample evidence that the resilience of the Chilean economy increased in the 1990s. This positive development took place even as the deeper integration of the economy with the rest of the world resulted in increased synchronization of the domestic business cycle with international conditions. This pattern underscores the significant countercyclical role played by policies, particularly monetary and structural policies.

The most straightforward policy implications of the results presented in this paper are that good policies matter and that demand management policies are a necessary complement of structural policies. This is clearly demonstrated by the increase in the Chilean economy's resilience throughout the 1990s, a period in which domestic policies were rather complementary. The profound economic reforms of the 1970s and 1980s undoubtedly played an important role in Chile's outstanding growth performance between the mid-1980s and 1997—that is, before the prolonged slowdown period that resulted from the Asian and Russian crises and the unsupportive external environment that characterized the global economy until recently. The policies of the 1970s and 1980s were highly procyclical, however, and the economy was therefore vulnerable to external shocks. Indeed, the economy underwent two large recessions during that period. Hence, the incumbent and future Chilean economic authorities should continue on the path of strengthening the macroeconomic policy framework and managing it skillfully. If they do so, we would expect the Chilean economy to further improve its already high level of shock resilience. If they do otherwise, resilience could easily deteriorate, and given the uncertainties embedded in the global environment, the economy could return to more turbulent times.

With regard to future research, adding more structure to the small open economy VAR could yield further insights by allowing a more accurate identification of shocks. In particular, the changing policy framework of the last fifty years is an important barrier to successfully fitting a more particular structure to the contemporaneous matrices implicit in the VAR estimation. One way to tackle this issue is to pursue a similar study using quarterly data for the last decade. Preliminary exercises suggest that a structural VAR model fitted on a quarterly sample covering a shorter period could potentially be well equipped to capture the dynamics of the data. The number of variables included in the VAR may need to be streamlined, however, considering the typical autocorrelation pattern that characterizes data at this frequency. Also, in line with Parrado (2001), a direction in which to build on the model developed in this paper is to evaluate the impact of foreign shocks and monetary policy on both the business cycle and inflation variability and its tradeoff.

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Policy Responses to External Shocks: The Experiences of Australia, Brazil, and Chile

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Open economies, particularly emerging markets and commodity-intensive economies, deal with large external shocks. These are typically of a financial nature in the case of the former and real—in that they affect the terms of trade—in the case of the latter. Alternative policy reactions and policy setups may dampen or amplify the consequences of these shocks, affecting the magnitude of the shock. It is therefore very important to analyze and evaluate alternative policy setups and policy reactions from different angles in order to draw lessons for the macroeconomic management of open economies.

This paper revisits the recent experience of policy frameworks and reactions in Australia, Brazil, and Chile. The objective of the paper is twofold: to describe the recent experience of these countries by providing an account of the macroeconomic policy framework and the policy reactions to the major shocks of the past eight years, and to draw some policy lessons. Taken together, the three cases are interesting for many reasons. First, the three economies have recently faced important external shocks,

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derived from the Asian crisis in 1997–98 and the lower world growth and higher risk aversion in 2001–02. Second, they all had an inflation-targeting regime in place at the moment they faced the shocks we analyze, although at rather different stages of maturity. Third, although they show significant differences in their levels of macroeconomic and institutional development, these in fact represent different phases of not-so-dissimilar development patterns. Finally, each chose quite different policy reactions, which enables us to analyze what could be important lessons.

The stage of maturity of the inflation-targeting regime in the three countries was different in several dimensions.[1] In 2002, Australia and Chile were already on a steady-state inflation level, whereas in 1998 Chile was about to converge to that level and Brazil was still in transition. Both the Brazilian and Chilean frameworks had annual targets in 1998, whereas Australia and Chile had longer policy horizons in 2002. In 1998 Chile did not have a floating exchange rate regime. In 2002 Brazil had to intervene in the foreign exchange market, while Chile made more limited interventions and Australia's interventions were even more limited.

Development heterogeneity is more marked than policy framework differences in these three countries. While Australia has a per capita income on par with industrialized countries, Brazil and Chile still classify as emerging economies. Financial market depth is also substantially different, with Australia having the most developed market. Openness to trade is substantially lower in Brazil than in the other two countries, while Chile ranks as the most open economy. Finally, two relevant features of these economies are the rather large public debt of Brazil and the issuance of external debt in local currency in Australia.

Macroeconomic performance has also differed in the three countries. Over the past ten years, Australia displayed fairly stable growth, low inflation, and a sizeable current account deficit. Brazil experienced lower growth, with significant volatility, declining inflation up to 1998, and improving current account balances. Chile posted a strong growth performance up to 1997, with declining inflation and a quite volatile current account deficit.

The policy reactions at the different junctures are quite diverse. In Australia in 1998 (and 2000), the real exchange rate depreciated, inflation increased, and the current account deficit widened (in 1998), with relatively stable growth of gross domestic product (GDP). In Chile

1. See the appendix for supplemental tables on the three countries' inflation-targeting regimes and economic indicators.

in 1998, the real exchange rate did not move significantly, inflation continued to decline, and the current account deficit, the investment rate, and the growth rate all dropped considerably. In 2002, the Chilean economy reacted similarly to what happened in Australia in the previous episodes. Brazil in 2002 suffered a real exchange rate depreciation, an increase in inflation, an important drop in the current account deficit, and, in 2003, a GDP growth deceleration.

This paper assesses a number of issues across the country cases. First, we analyze the extent to which policy responded in a countercyclical fashion to the various shocks. In particular, did interest rates rise or fall in reaction to the crisis, or, equivalently, was the currency allowed to depreciate in response to negative external shocks? Was fiscal policy changed in response to the crisis? Second, we examine the factors that can constrain policymakers' options, including initial macroeconomic conditions (public debt, current account deficit, exchange rate pass-through, initial inflation), previous institutional development (openness, fiscal responsibility, financial deepening), the existence of a framework, and the risk distribution between the private and public sectors (balance sheet exposures), which leads to intertemporal considerations. Third, we assess the trade-off between flexibility and credibility, stressing the importance of building credibility in the reaction to shocks. How much flexibility is appropriate? Did the response stay within the established framework? Were the goals short term or medium term? Finally, we classify the type of intervention policy pursued in the three countries.

The paper is organized as follows. Section 1 describes the Australian case; section 2 reviews the Brazilian experience; and section 3 assesses the Chilean episodes of 1998 and 2002. Finally, section 4 derives some policy lessons.

1. Australia: Policy Response to External Shocks

Australia operates a flexible inflation-targeting regime with the objective of ensuring that consumer price index (CPI) inflation averages between two and three percent over the business cycle. This regime was put in place informally in 1993 and was formalized in 1996 with the release of a joint statement on the conduct of monetary policy by the Governor of the Reserve Bank of Australia and the Australian Treasurer.

The adoption of this regime followed two decades of poor inflation performance, with CPI inflation averaging around 10 percent in the

1970s and 8 percent in the 1980s. Its adoption, however, was not part of a strategy to reduce inflation, since inflation had already fallen to around 2 percent in 1993, largely as the result of a severe recession (see figure 1, panel B). Rather, the inflation target was seen as a way of ensuring that the hard-won reduction in inflation was sustained.[2]

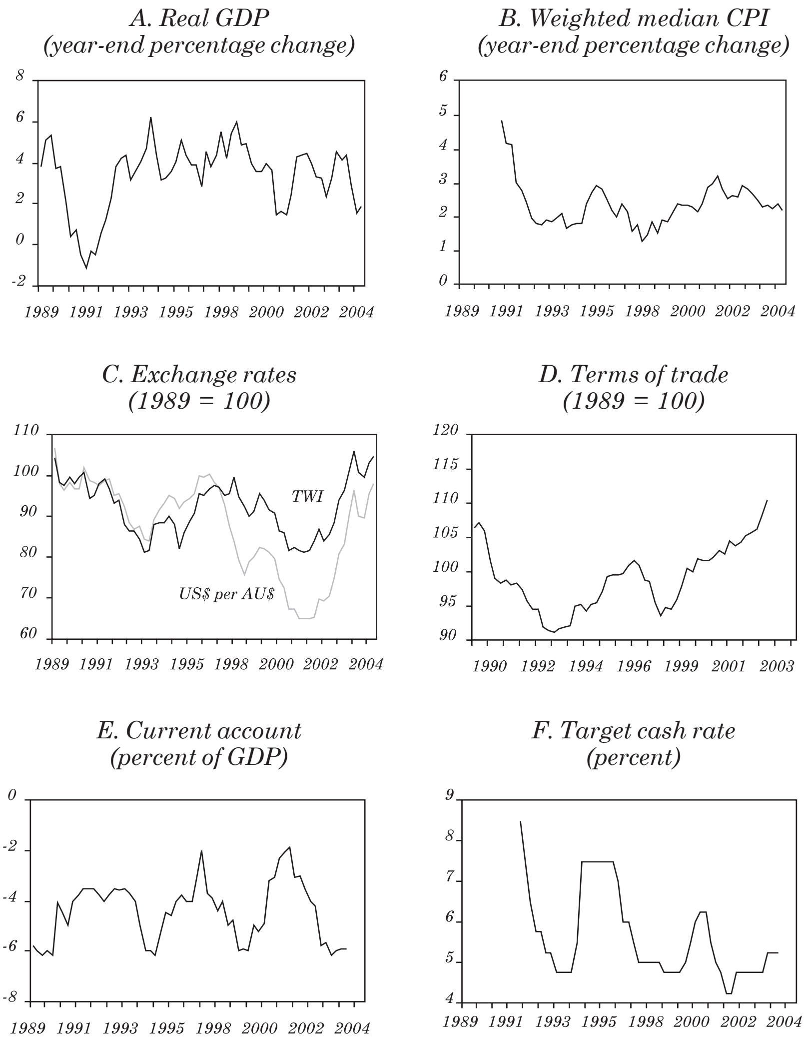
From the outset, Australia's inflation targeting framework has been more flexible than those of some other countries; it has never specified an explicit annual target or incorporated formal sanctions on the Reserve Bank of Australia or Governor for missing the target. In the initial years, some observers saw this as a lack of commitment to the regime, although more recently, a number of countries have implemented similar frameworks. The adoption of a flexible, as opposed to a strict, inflation target largely reflected the recognition that while monetary policy's primary focus is medium-term price stability, it should also take into account the trade-off between inflation and output variability. This flexibility can be useful for responding to supply shocks, movements in the exchange rate, and developments in asset markets.

At the operational level, monetary policy is set in terms of a target for the rate at which banks lend to one another in the overnight money market (the so-called cash rate). Most bank loans to the business and household sectors have variable interest rates, and these variable rates move closely with the target cash rate. The Reserve Bank of Australia influences the cash rate through its daily open market operations, which affect the supply of balances that financial institutions maintain at the Reserve Bank of Australia to settle interbank obligations. The actual cash rate is typically within one basis point of the target. Australia does not have any reserve requirements.

The monetary framework operates within the context of a floating exchange rate and free movement of capital. The Australian dollar was floated and capital flows were liberalized in late 1983, almost a decade before the adoption of an inflation target. In the three years after the float, the Australian dollar depreciated by over 30 percent in trade-weighted terms, but thereafter it broadly cycled around a relatively flat trend. The period was characterized by three major cycles, with the exchange rate against the U.S. dollar troughing as low as US$0.48 and peaking as high as US$0.87. These cycles largely, though not exclusively, reflected movements in commodity prices

2. For a review of Australia's experience with inflation targeting, see Stevens (1999, 2003).

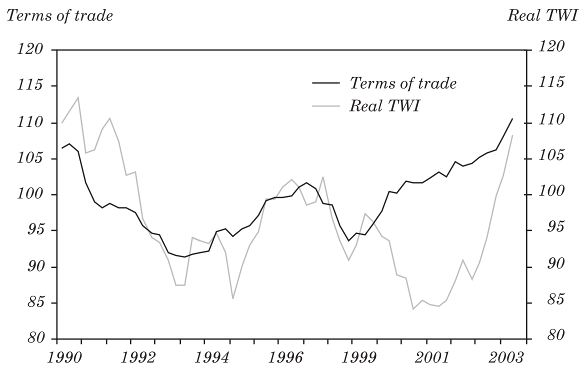
Figure 1. Australia: Macroeconomics Indicators



Sources: Australian Bureau of Statistics and Reserve Bank of Australia.

and, hence, Australia's terms of trade (figure 2). The main exception to this was in 2000–02, when the currency was unusually weak given movements in the terms of trade (see below).

Figure 2. Australia: Real Exchange Rate and Terms of Trade



Sources: Australian Bureau of Statistics and Reserve Bank of Australia.

Notwithstanding the generally stabilizing role played by the exchange rate, the Reserve Bank of Australia has on occasion intervened heavily in the foreign exchange market. Such intervention is, however, relatively rare and is undertaken in response to movements in the exchange rate that seem excessive relative to changes in economic or financial conditions. As such, this type of intervention typically takes place only after the exchange rate has already appreciated or depreciated significantly, and it is often intended to restore a sense of two-way price risk, thereby lessening momentum which might otherwise lead to further overshooting. Intervention is not used to pursue a particular level of the exchange rate.

Since 1990, Australian GDP has grown at an average annual rate of 3.25 percent (figure 1, panel A). The economy experienced a severe recession in the early 1990s, largely as a result of the unwinding of the credit and commercial property boom of the late 1980s, as well as the recession in the United States. Since 1992, the economy has experienced thirteen years of consecutive expansion with growth averaging almost 4 percent. The low point in growth over this period was in the year from June 2000 to June 2001, when GPD expanded by just 1.50 percent. This outcome largely reflected an exceptionally large decline in housing investment associated with the transitional effects of introducing a revised indirect tax (the Goods and Services Tax).

The overall strong growth performance of the Australian economy has been achieved despite two significant adverse external shocks—the Asian/Russian financial crises of 1997–98 and the the U.S. recession in 2001. In previous decades, these shocks might have caused significant disruptions to the Australian economy. That they did not is attributable to a range of factors, not least of which is the flexibility of the Australian dollar. These factors are discussed in detail below.[3]

1.1 The Asian and Russian Crises

In 1998 and 1999 Australia recorded average growth of nearly 5 percent—higher than the average of the past decade—despite the financial and economic turmoil in some of its largest trading partners. While external demand and Australia's terms of trade clearly weakened over this period, the effect on growth was more than offset by strong domestic demand. Reflecting this, the current account deficit doubled from around 3 percent of GDP prior to the crisis to a peak of around 6 percent in 1999 (see figure 1, panel C).

Given the close trading links between Australia and Asia, the Australian dollar depreciated significantly in response to the turmoil. Against the U.S. dollar, the currency depreciated by almost 20 percent between mid-1997 and late 1998, while in trade-weighted terms the fall was only 6 percent given the sharp appreciation of the Australian dollar against the devalued Asian currencies. Largely in response to the depreciation, underlying inflation rose from around 1.5. percent prior to the crisis to around 2.5. percent in late 1999. This increase was considerably less than would have been expected based on the historical relation between inflation and the exchange rate (see below).

Throughout the crisis period, monetary policy remained expansionary. At the time of the Thai devaluation, the target cash rate stood at 5 percent, which was two percentage points below its level a year earlier (figure 1, panel F). The target rate remained unchanged until late 1998, when it was reduced to 4.75 percent. The decision to maintain expansionary policy through this period distinguishes the Australian experience from that of some other countries and reflects three key factors: the cyclical starting point was advantageous; foreign exchange risks were well managed; and markets retained confidence in the macroeconomic and structural policy settings in Australia. We discuss each of these factors in turn.

3. See also Macfarlane (2001).

Advantageous cyclical starting point

At the time of the Asian crisis, the Australian economy was growing strongly, and the underlying inflation rate was a full percentage point below the medium-term target. This meant that the immediate inflationary consequences of the depreciation were of less concern than might have been the case had inflation been above the medium-term target when the crisis hit.

Foreign exchange risk management

The depreciation of the exchange rate was unambiguously expansionary, as has been the case in other countries with well-developed financial markets. In particular, the depreciation was not associated with an increase in Australia's country risk premium, and it did not lead to concerns about the balance sheet effects of currency mismatches of either the banking or corporate sectors. This was despite the fact that at the time of the crisis, Australia's net foreign debt was equivalent to around 42 percent of GDP, with the net debt of financial intermediaries accounting for around 60 percent of this total. While much of the banks' overseas liabilities were (and still are) in the form of foreign currency bonds, the banks maintained very little currency risk on their own balance sheets owing to the extensive use of foreign currency derivatives. In 2001, for example, the banking sector had outstanding foreign currency debt amounting to A$117 billion, offset by a net long position in derivatives of A$109 billion. The sector's main foreign exchange exposure results from its equity investment of offshore operations, which are intentionally left unhedged.[4]

The derivative contracts used to hedge the currency exposure were undertaken mainly with nonresidents. Some of these entities had borrowed Australian dollars and were seeking to swap their liability back into their own currency, while others were investors who were looking for exposure to the Australian dollar. The derivatives market on which the Australian banks so heavily rely has developed over many years, and it reflects both the liquidity in the Australian dollar spot market and, more fundamentally, a willingness of foreign investors to take on Australian dollar risk. This willingness is partly an outcome of Australia's relatively stable macroeconomic and financial framework.

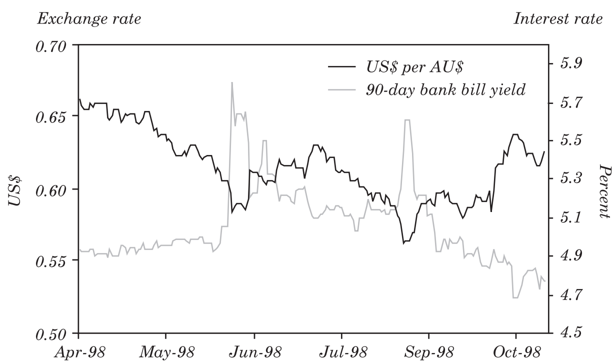
4. For more detail, see Reserve Bank of Australia (2002). See also Caballero, Cowan, and Kearns (2004).

Market confidence

At the time of the Asian crisis, fiscal policy had moved into surplus and the level of government debt to GDP was low by international standards. Australia's banking system and financial infrastructure were both widely recognized as being in sound shape. Moreover, the expectation of low inflation had become reasonably well embedded, as had the view that a decade or more of structural reform had delivered a substantial pickup in the underlying rate of productivity growth in Australia. Together, these factors meant that international investors were prepared to fund a significant increase in the current account deficit, albeit at a much lower exchange rate. They also meant that the market was reasonably confident that the temporary pickup in inflation associated with the depreciation would not translate into a troublesome pickup in inflation expectations.

The policy response of maintaining expansionary monetary policy and allowing the currency to depreciate was clearly successful. There were, nonetheless, some difficult moments.[5] In June 1998, large international fund managers and exporters—who would normally have been natural buyers of Australian dollars—undertook extensive speculative selling of Australian dollars. This speculation occurred after the exchange rate had already depreciated significantly, and it caused the Australian dollar to fall US$0.04 in a few days. This drop led financial markets to quickly price in a 75 basis point increase in interest rates over the next few months (figure 3).

Figure 3. Australia: Exchange Rate and Interest Rates, 1998



Sources: Australian Bureau of Statistics and Reserve Bank of Australia.

5. The following discussion on intervention draws heavily on the Reserve Bank of Australia's Annual Reports for 1997–98 and 1998–99.

In contrast to this market expectation, the Reserve Bank of Australia did not increase interest rates and instead undertook a heavy round of foreign exchange intervention, purchasing around A$2.6 billion in the spot market in June. At the time, the Reserve Bank judged that higher interest rates were not justified on general economic grounds, and that the highly uncertain environment created a substantial risk that the short-run dynamics would cause the exchange rate to move by more than could be reasonably justified by the changed fundamentals. Given this assessment, the authorities considered intervention in the foreign exchange market to be the most appropriate response. The approach was largely successful. Two-way price risk was reintroduced into the market, and the exchange rate appreciated by around US$0.02 in the second half of June. As market expectations of a tightening of monetary policy gradually waned, the short-term yield curve became broadly flat again by end July.

A second difficult period occurred following the Russian crisis in late August. Again, the exchange rate came under significant downward pressure, and short-term market interest rates increased. As in June, the Reserve Bank of Australia intervened to support the Australian dollar, although instead of relying solely on outright purchases of Australian dollars (as it had done in the past), it also purchased call options on the currency. This permitted the Reserve Bank to stimulate a significant demand for Australian dollars—triggered initially by the dealers who had sold the options—for a limited outlay. The sharp fall in the exchange rate was reversed. The options, which were then in profit, were resold. Conditions in the foreign exchange market stabilized over the following months, and the Reserve Bank cut the target cash rate by 25 basis points in December.

1.2 The U.S. Recession

The second major external shock was the U.S. recession in 2001. The macroeconomic performance of Australia and the United States was very similar in terms of output and inflation in the 1990s. However, while Australian growth slowed in response to the U.S. recession, the economy was able to considerably outperform the global economy. As in the case of the Asian crisis, weak world demand was counterbalanced by strong domestic demand, resulting in the current account deficit again increasing to around 6 percent of GDP. Unlike the Asian crisis, the exchange rate appreciated slightly, albeit from a very low level, and the terms of trade experienced a modest increase, partly as a result of the falling world price of manufactures.

The solid performance of the Australian economy despite the difficult international environment can be explained by a number of factors. First, Australia avoided the worst of the stock market and investment excesses associated with high-tech sector, and it was thus spared the worst of the fallout. This reflects, in part, the absence of a large information technology production sector in Australia.

Second, the level of the exchange rate in 2000–02 was very expansionary. In 2000 and early 2001, the Australian dollar depreciated by around 25 percent against the U.S. dollar to a record low. For the three-year period from 2000 to 2002 as a whole, the real value of the Australian dollar against the U.S. dollar was 23 percent below its average level since the float. This weakness in the currency was unexpected, particularly given the increase in Australia's terms of trade during this period.[6] Indeed, it was the first time since the float that the exchange rate had depreciated considerably when the terms of trade were rising. This outcome reflected the view among certain investors that Australia was an "old economy" with only a small information technology sector. The level of capital inflow declined, and correspondingly the current account deficit narrowed to just below 2 percent of GDP in early 2001, its lowest level in twenty-two years. As noted above, the deficit subsequently widened to around 6 percent of GDP, as Australian assets once again became more attractive given the relatively strong performance of the Australian economy.

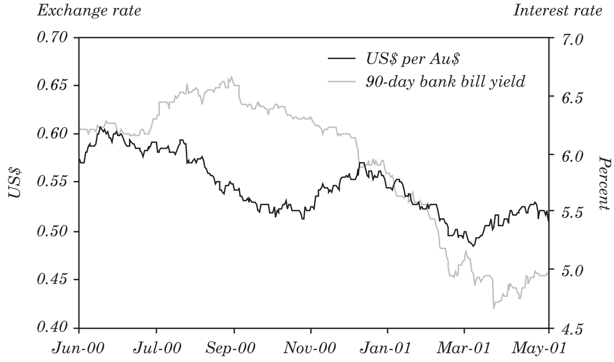
Third, Australian households have long been prepared to borrow heavily, mainly for housing. This borrowing underpinned a strong construction sector and pushed up house prices, generating a positive wealth effect for existing homeowners.

In terms of policy, an interesting aspect of this period is the monetary policy response to the large swings in the exchange rate. Between November 1999 and August 2000, when the Australian dollar was depreciating, the Reserve Bank of Australia increased the target cash rate by 2 percentage points. This increase was designed to withdraw the monetary stimulus that had been in place during the Asian crisis. The weak exchange rate was not a primary reason for tightening policy, although it did suggest that the stimulus was no longer required.

6. For a full discussion of exchange rate movements around this time, see Macfarlane (2000).

The exchange rate continued to depreciate through 2000 and into 2001, reaching a record low of US$0.4775 in April 2001. At the same time, the deterioration in the international economy undermined the case for tighter policy on general macroeconomic grounds. The Reserve Bank therefore undertook a round of foreign exchange intervention, as in 1998. Total intervention between September 2000 and April 2001 amounted to around $2.5 billion (around the same as in June 1998) and was conducted through both purchases of call options on the Australian dollar and outright purchases of Australian dollars. In contrast to the earlier episode, the intervention was spread out over a longer period, and market interest rates did not spike when the Australian dollar was depreciating sharply (see figure 4).

Figure 4. Australia: Exchange Rate and Interest Rates, 2000 and 2001



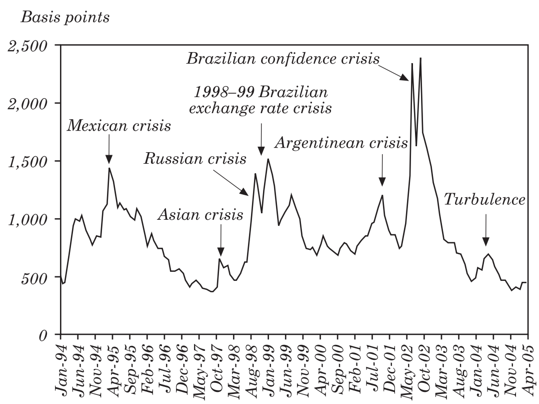
Sources: Australian Bureau of Statistics and Reserve Bank of Australia.

The fall in the exchange rate in 2000 led to a rise in forecast inflation. In late 2000, for example, the Reserve Bank of Australia was expecting inflation to increase to around 3 percent over the next year or so. The authorities did not tighten monetary tightening further, however, as the increase was largely seen as temporary given the deterioration in the world economy and the apparently well-anchored inflation expectations. As was the case with the 1997–98 depreciation, the pass-through into domestic prices was relatively muted. This reflects a number of factors, including well-anchored inflation expectations, the ability of businesses to hedge currency risk, and the unwillingness of firms to increase prices in a low-inflation world, particularly when the exchange rate is viewed as having a large cyclical element.

2. Brazil: Policy Response to External Shocks

Brazil had no lack of shocks and crises over the last ten years. The Mexican crisis hit Brazil shortly after the Real Plan successfully stabilized the currency after years of hyperinflation, and it was followed by the Asian crisis, the Russian crisis, the 1999 floating of the real, the Argentine crisis, and, finally, the power and election crises. In all of these occasions, Brazil's financial and real variables suffered (see the Brazilian spread over U.S. Treasury bonds in figure 5).

Figure 5. Brazil: EMBI Sovereign Spread



Sources: J.P.Morgan and authors' calculations.

Over time, Brazil developed a set of reactions and policies to withstand large shocks, such as the appropriate timing of intervention to allow further depreciation or to tap the resources of the International Monetary Fund (IMF). Some policies developed into frameworks, as in the case of the inflation-targeting regime and the way the Central Bank reacts to shocks. Even the country's relationship with the IMF during a crisis provides lessons for other countries that may come to face similar events.

In the rest of this section, we introduce the current policy framework as it has evolved since the Real Plan. We then describe the policy reaction to the 2002 crisis, the role of the IMF, and the framework developed by the Central Bank to deal with the increased volatility.[7]

7. We concentrate on the 2002 crisis and policy reactions. Most of the policy reactions to previous shocks are embedded in the rules and frameworks developed for this case.

2.1 Policy Framework

In the 1980s and early 1990s, Brazil experienced chronic high inflation despite a series of failed stabilization plans involving six monetary reforms in ten years. Potential GDP growth was hampered, and all sorts of distortions developed. Unlike other high inflation countries in Latin America, the Brazilian economy was never dollarized. Instead, indexation—the adaptive policy response—became pervasive throughout the economy, and its capacity to accommodate inflation may partially explain Brazil's failure to engage in serious structural change before 1994.

The Real Plan of July 1994 succeeded in reducing inflation through an exchange-rate-based stabilization program that introduced a transitory unit of reference for prices. In March 1994, nominal prices, wages, and other contracts were allowed to be quoted in a unit of real value (*Unidade Real de Valor*, or URV) that would be replaced by a new currency, the real, in July 1994. The key issue was to coordinate a deindexation process to break the inflationary inertia, since the automatic price adjustments to past inflation were not synchronized. The Central Bank fine-tuned the URV daily to reflect the currency's loss of purchasing power. In the interim period after the introduction of the URV and before its replacement by the new currency, it was expected that relative prices would converge to their equilibrium value. This was important to the second phase of the conversion, when the URV would be transformed into the real on a one-to-one basis. The plan caused inflation to plunge from 46 percent in June 1994 to 1.5 percent in September 1994, and it succeeded in keeping inflation low in subsequent years. The use of the exchange rate as the main anchor for monetary policy was not sustainable, however, since the currency remained overvalued in real terms for several years.

Brazil adopted inflation targeting in early 1999, after floating its currency and experiencing a 50 percent nominal depreciation. Inflation targeting was one element of a wider policy regime that entailed the announcement, a year earlier, of a sequence of increased primary budget surpluses. The new monetary regime worked well: the initial inflation targets were set at 8 percent for 1999 and 6 percent for 2000, with a 2 percent tolerance range. In December 1999 the twelve-month inflation rate was 8.9 percent; the following December it was 6 percent, exactly on target.

This successful start was followed by two difficult years, in which Brazil was hit by contagion from Argentina, a domestic energy crisis, a widening of bond spreads worldwide, a sudden reversal in capital flows amounting to 6 percent of GDP, and the political uncertainty surrounding the 2002 presidential campaign. During this period the real depreciated again, by 20 percent in 2001 and 50 percent in 2002. Inflation temporarily increased to as much as 16 percent, but it was back to 6 percent by March 2004.

Despite the large shocks, private sector inflation expectations did not depart significantly from the country's inflation targets until September 2002. In 2003, after a quarter of high inflationary expectations, both inflation and expectations converged back to the targets.

2.2 The 2002 Crisis

Brazil underwent a severe stress test in 2002, mainly as a result of the uncertainties related to the presidential campaign, but also in response to the widening of spreads worldwide, especially on U.S. corporate bonds.[8] The economy registered a sudden stop in capital flows amounting to 6 percent of GDP, an exchange rate depreciation of almost 50 percent, and a substantial increase in the Brazilian bond spread over U.S. Treasury bonds.[9] The real depreciation and the sudden stop in capital inflows required a sharp adjustment in the current account (5 percent of GDP from 2001 to 2003) and a corresponding reduction in domestic absorption, mostly private consumption and investment.

The sudden stop and the resulting depreciation also led to an increase in the amount of public debt as a fraction of GDP, because of the composition of Brazilian public debt. Both domestic and external public debt were linked to the exchange rate: 30 percent of domestic debt was indexed to the nominal exchange rate and, as in most emerging markets, all public external debt is denominated in strong currencies. Consequently, the ratio of net public debt to GDP jumped from 0.54 to 0.63 in a few months.

The composition of public debt in Brazil has been an important issue for a while. The unwillingness of the private sector to bear currency risk limits the government's ability to reduce the dollar-linked component of the debt. After two years of continuous reduction (1999–2000), the proportion of dollar-linked debt increased again in 2001. Only since mid-2003 has the government been able to reduce this component of the debt once again.

8. This section draws on Giavazzi, Goldfajn, and Herrera (2005).

9. The expression sudden stop reflects a rapid collapse in net capital inflows into the country; it is defined and analysed in Dornbusch, Goldfajn, and Valdés (1995).

Doubts regarding the sustainability of the debt mounted as public debt increased, and investors became suspicious about the economic policies that would be adopted after the election. At one point in mid-2002, the market began to price into Brazilian bonds a risk of default within the coming twelve months. The J.P. Morgan Emerging Market Bond Index (EMBI) spread (the difference between the yield on dollar-denominated bonds issued by Brazil and the yield on equivalent U.S. Treasury bonds) moved from 700 basis points in March to 2,400 basis points at the end of July.

The uncertainty regarding the sustainability of public debt induced market participants to reduce their exposure to public debt or seek shorter-term government securities. As a result, the discount on long-term domestic government securities widened substantially, and the debt maturity was shortened. The average maturity of SELIC-indexed debt held by the market fell from thirty-six months in March 2002 to twenty months in January 2003, and the percentage of debt coming due in the following twelve months rose from 6 percent to about 50 percent.[10]

The inflation targeting regime also underwent a direct stress test. The exchange rate depreciation (and doubts regarding monetary policy under the new government) led to a rise in expected inflation: one-year-ahead inflation expectations increased from 4.5 percent in March to 5.3 percent in early August and 10 percent in October.

2.3 Policy Reaction

The sudden stop raised a number of challenges for the government. First, the government had to restore confidence on future policies to

10. The Special Settlement and Custody System (SELIC) overnight rate, expressed in annual terms, is the average rate weighted by the volume of one-day operations guaranteed by federal government securities, carried out at SELIC through committed operations; it is the basic reference rate for monetary policy (see the Central Bank of Brazil website, at www.bcb.gov.br/sddsi/txselic_i.htm). Mutual funds, which held 30 percent of the domestic public debt, were particularly vulnerable to the widening of the discount on longer-term securities. Since these institutions were de facto issuing very liquid liabilities against long-term government bonds, the losses on their assets induced heavy withdrawals from depositors. Moreover, some funds were delaying the recognition of the losses on their balance sheets, thereby increasing the risks of runs on their liabilities. To avoid that, the Central Bank actively enforced the mark-to-market regulations, leading in the short run to more recognized losses and withdrawals. Eventually, and partially as a result of Central Bank intervention, the discounts stopped widening, further losses were prevented, and withdrawals were cut short.

avert the net capital outflows and reduce doubts regarding debt dynamics. Second, the Central Bank had to evaluate whether the impact of the exchange rate depreciation would be limited to a one-time change in the price level, or whether inflation would remain high even after the exchange rate had stabilized. In this regard, the Central Bank had to determine how fast and by how much to raise interest rates. Third, the government had to manage the sharp fall in the demand for long-term government securities and avoid a roll-over crisis.

The depreciation had rapidly increased the ratio of public debt to GDP. This called for an increase in the primary surplus if the level of the debt were to remain stable at this new level; alternatively, the debt level could fall as the result of a reversal of the exchange rate depreciation. Market confidence in future fiscal policies was necessary, but there was widespread uncertainty as to the policy that the future government would adopt.

The situation called for a change in expectations regarding future fiscal and monetary policy. The government faced serious issues, however, of how to achieve a commitment on future fiscal policy from the leading candidates in the midst of the campaign and how best to conduct monetary policy act in the process. A first response came in August, when the IMF granted Brazil a US$30 billion loan—the largest ever in IMF history—conditional on Brazil maintaining "responsible policies" over the next few years in terms of fiscal primary surpluses, inflation targeting, a floating exchange regime, and respect of contracts, including the public debt. The purpose of the loan was not only to provide the Central Bank with foreign exchange reserves, but also to provide a mechanism that would help the main candidates coordinate their public support for sound policies. The candidates came through with their statements, and while some were more vague than had been hoped, they certainly helped avoid a further deterioration of market conditions before the October elections. More importantly, the leading candidate started sending stronger signals that he was prepared to adopt the fiscal stance required to stabilize debt dynamics.

At the same time, it became progressively clearer that the exchange rate depreciation would have persistent effects on inflation. (We explain in detail below how the Central Bank confronted the rise in inflation.) Understanding the response of price setters to changes in the exchange rate was crucial for determining the optimal monetary policy response, since the larger and more persistent the effect on prices, the longer is the horizon needed for inflation to return to the target path. The most recent experience prior to the crisis was that of 1999: after a 60 percent depreciation, inflation increased temporarily to 9 percent, but at the end of 2000 it was back to 6.0 percent, the mid-point of the central bank's target range.

One big difference between 1999 and 2002, however, was the level of the real exchange rate before the depreciation. To compare the exchange rates, we use an indexed based on thirteen currencies and normalized to 100 in 1994; a fall in the index indicates a real appreciation. In 1999, before the devaluation, Brazil's effective real exchange rate based on this index was 95.7; in 2002, it was 150. As shown in Goldfajn and Werlang (2000), the level of the real exchange rate before a devaluation is an important factor in determining the pass-through from the exchange rate to prices. When the real exchange rate is weak, foreign exporters enjoy large margins and can afford to cut them to preserve their market shares, thus dampening the pass-through. This was the case in 1999, but not quite the situation in 2002.

At this point monetary policy reacted strongly. The SELIC rate was raised from 18 to 21 percent on October 15 and then to 25 percent in mid-December; the real rate jumped from 11 to 18 percent, consistent with a monetary policy rule that responds more than proportionately to an increase in inflation expectations. President Luiz Inacio Lula da Silva eventually delivered on his promises: the new government maintained the floating exchange regime and inflation targeting, made clear that public debt would be honored, and increased the primary surplus by half a percent of GDP. (The shift in perceived fiscal policy was large; expectations were that primary surplus would actually fall by a few percentage points.)

Central Bank framework for dealing with shocks

In early 2003 the Central Bank realized that it was not feasible (under reasonable output loss estimations) to pursue the original targets set a couple of years earlier.[11] The depreciation, together with doubts regarding monetary policy under the next government, caused annualized inflation to reach 6 percent just in the last quarter of 2003 (30 percent annualized). Simulations based on a set of assumptions indicated that a convergence trajectory that reached 6.5 percent in 2003 (the ceiling of the target tolerance interval) would have implied

11. This section draws on Fraga, Goldfajn, and Minella (2004).

a 1–2 percent drop in GDP. A trajectory that reached the center of the target (4 percent) in 2003 would have implied an even larger decline in GDP (–7 percent).

The decision was therefore made to gear monetary policy toward converging inflation to the original target tolerance interval in two years rather than one (two years is no magic number; it all depends on the size and type of the shock) and to pursue a trajectory compatible with end-of-year adjusted targets of 8.5 percent in 2003 and 5.5 percent in 2004.

Of course, breaching original targets always carries credibility costs. Given the size of the shocks, however, credibility losses could also stem from a decision to keep the old target, because that might be considered unattainable (and for all practical purposes, dropping from an annualized rate of 30 percent to a 6 percent ceiling rate in one year was not achievable). The decision to keep the original targets must weigh these two effects. In the end, the Central Bank opted to pursue the original targets over a longer horizon and to increase communication (and transparency) to explain that this path offered the best inflation/output trade-off.

We now turn to the Central Bank of Brazil's methodology for dealing with shocks. The methodology, which is built on the recent experience with inflation targeting during turbulent times, calculates the inflationary impact of current supply shocks as well as the secondary impact of past shocks (due to inertia in the inflation process). The idea is simply to accommodate the direct impact of current shocks and to choose a horizon to weed out the secondary impact of past shocks. Thus when facing shocks, the Central Bank of Brazil initially considers the nature and persistence of the shock. It then builds different inflation and output trajectories associated with different interest rate paths. Based on its aversion to inflation variability, it chooses the optimal path for output and inflation. The Central Bank of Brazil (2003) has published this path and also the outcome of different paths. This is in line with Svensson's (2002) recommendations.[12]

If shocks are large or persistent (or both), their inflationary effects may last one year or more. The optimal inflation path may imply a twelve-month-ahead inflation level that is higher than the previous annual target. In this situation, the Central Bank of Brazil would not be targeting the previous inflation target, so it uses an adjusted target that takes into account the primary effects of changes in relative prices

12. Svensson's (2002) recommendations also involve publishing the corresponding instrument-rate plan.

and of any past inertia that must be accommodated. The adjusted target thus starts with the target previously set by the government and adds the primary effect of the shock on regulated-price inflation and the inflation inertia inherited from the previous year that is to be accommodated in the current year. The new target is publicly announced. When the economy is facing cost shocks, such as the increase of regulated prices above the inflation of the other prices of the economy, monetary policy should be calibrated to accommodate the direct impact of shocks on the price level, but to fight their secondary effects. Furthermore, since the Central Bank also takes into account output costs, the inertial impacts of the previous year's inflation should not necessarily be fought completely.

Changes in relative prices, such as the prices of regulated utilities and the exchange rate, have been one of the main challenges faced by the Central Bank of Brazil. Since the implementation of the Real Plan in July 1994, regulated-price inflation has been well above the market-price inflation, for a variety of reasons. The ratio of regulated prices to market prices rose 31.4 percent between the start of the inflation targeting period (July 1999) and February 2003. As long as there is some downward rigidity in prices, changes in relative prices are usually translated into higher inflation. If these increases are treated as a supply shock, monetary policy should be oriented toward eliminating only their secondary impact on inflation, while preserving the initial realignment of relative prices. The Central Bank's effort to quantify the first-order inflationary impact of regulated-price inflation has therefore become particularly important, since it helps to implement monetary policy flexibly and without losing sight of the larger objective of achieving the inflation targets.[13]

This methodology was applied to the Brazilian case after the 2002 crisis, for inflation in 2003 and 2004.[14] In an open letter to the Minister of Finance in January 2003[15], the bank explained why the exchange rate

13. The first-order effect on market prices (in contrast to regulated prices) are not calculated. The methodology assumes that the primary shock to market prices tends to occur fastest within the first quarter after the shock. The full primary shock to market prices is thus assumed to have already occurred when the adjusted targets are calculated.

14. See Central Bank of Brazil (2003). For a more detailed explanation of the methodology, see Freitas, Minella, and Riella (2002).

15. Under the presidential decree that introduced inflation targeting, the Central Bank of Brazil is required to submit an open letter to the Ministry of Finance explaining the causes of any breach of the inflation target and the steps to taken to get the inflation rate back down.

had overshot and made explicit estimates of the size of the shocks and their persistence. It estimated the shock from administered prices to be 1.7 percent and the inertia from past shocks to be 4.2 percent, of which two thirds was to be accepted, resulting in a further adjustment of 2.8 percent. The Central Bank added these two numbers to the previously announced target of 4.0 percent to get an adjusted inflation target for 2003 of 8.5 percent that is, 4.0 percent plus 1.7 percent plus 2.8 percent). The letter indicated that an attempt to achieve an inflation rate of 6.5 percent in 2003 would entail a fall of 1.6 percent in GDP, whereas trying to achieve the nonadjusted target of 4.0 percent would lead to a decline in GDP of 7.3 percent. Ultimately, inflation in 2003 ended up at 9.3 percent, very close to the adjusted target, and GDP declined by 0.2 percent.

In the inflation targeting design, a core inflation measure or the establishment of escape clauses have also been used or suggested as a way of dealing with shocks and volatilities. The main argument against the use of core inflation is that it is not fully representative of the loss of the purchasing power of money, at a given point in time. Agents are concerned about the whole consumption basket. In the Brazilian case, excluding the regulated price items would imply leaving out more than 30 percent of the representative consumption basket. Private agents may therefore question a monetary policy that is not concerned about the overall consumer price index.

In general, the adjusted target has two advantages. First, the core inflation measure is not necessarily isolated from the effect of shocks. For example, the large depreciation shock of the Brazilian economy in 2002 raised core inflation way above the inflation target. Second, the construction of the adjusted target is directly based on the idea that monetary policy should neutralize second-order effects of supply shocks and accommodate the first-round effects, and on the fact that some weight to output volatility should be assigned in the objective function. Therefore, some principles under which monetary policy is conducted become more transparent.

In the case of escape clauses, the circumstances under which the Central Bank can justify the nonfulfillment of the targets are set in advance. It has more similarities with the adjusted target procedure than with the use of core inflation as it does not exclude items from the inflation target, but defines circumstances in which the breach of targets can be justified. The main advantages of the adjusted target procedure are threefold: it is a forward-looking procedure; it clearly defines the new target to be pursued by the Central Bank; and it explains how the new target is measured.

The role of the IMF

The IMF played an important role in the crisis management. IMF skepticism regarding the success of the Real Plan in 1994 led to a lack of effective dialogue between the institution and the Brazilian authorities. In 1994–97, effective dialogue was not vital: inflation stabilization was a success, capital flows were abundant, and the Brazilian risk premium reached record low levels. Brazil was not engaged in a program with the IMF, as it was not needed.

The Fund's surveillance could have had a role in advising Brazilian authorities of the need for fiscal and external adjustment early in the process. In fact, surveillance papers often mentioned the need for further fiscal consolidation (although they did not take a strong position on the exchange rate regime).[16] However, the IMF's comments during this period lacked the necessary emphasis and had little impact on Brazilian economics and politics. The explanation resides in both the lack of effective dialogue between the IMF and the Brazilian government and the fact that market conditions remained favorable during this period.

The turbulence in international markets after the Asian crisis and, in particular, the Russian crisis triggered the need for a formal IMF program and financial assistance to Brazil in 1998. The program was centered on the fiscal adjustment, but it maintained support for the exchange rate regime. Despite progress on the fiscal accounts, market forces obligated Brazil to change its exchange regime, and the program was revised in March 1999.

The IMF's most interesting role came during the 2002 crisis. The market turbulence had an important political component, but IMF officials were not directly involved in talks with politicians. Both the Cardoso administration and the IMF understood that it would not be beneficial for all parties involved if an international organization was seen to be engaged in the political process. The reforms and economic adjustments were exclusively in the interest of the Brazilian people, and that is how they were to be seen. The Brazilian government had always expressed strong ownership of the reforms and adjustments; this was an important message to transmit to the future government.

Although the IMF would not engage in political negotiations, it was essential for Brazil and the future IMF program that the candidates agree on basic principles. It clearly was not feasible to engage the

16. See IMF, Independent Evaluation Office, "The IMF and Recent Capital Account Crises: Indonesia, Korea and Brazil," 2003.

candidates in detailed negotiations of a program with the IMF. The outgoing administration had to negotiate with the IMF in broad terms and then present the agreement to the candidates in the hope that they would publicly indicate their support. This strategy would only be feasible if the IMF program did not contain detailed conditionalities to be fulfilled by the future government. This required a delicate balance, since a coherent economic program usually involves future commitments. The outgoing administration was very firm, however, in not imposing either abundant or stringent conditionalities on the future government. The diagnosis by both the IMF and the government was that the solution to the uncertainties regarding the future of Brazil relied not on establishing further measures, but rather on guaranteeing that current policies would be followed in the future. The most important example is the target for the primary surplus. Both IMF staff members and some economists in the government believed that raising the primary surplus could provide a cushion for unforeseen events that could affect debt dynamics. Nevertheless, the most senior officials in the government and at the IMF rightly agreed and emphasized that the overwhelming priority was to devise a program that obtained support from all parties involved with regard to fiscal and monetary responsibility and respect of contracts.

2.4 Results

Far from falling into a vicious circle, the economy rapidly stabilized. The EMBI spread fell to 1,500 basis points by the end of December 2002: a year later, when Brazil's rating was raised from B to B+, the spread fell to 450 basis points—100 points less than in February 2002, before the crisis had started. As had happened on the way up, part of this reduction is explained by the simultaneous reduction in the U.S. corporate bond spread, which fell 200 basis points between October 2002 and December 2003, but there is little doubt that markets' perceptions of Brazil had shifted. The exchange rate stabilized and inflation expectations, which had been rising for six month, were back to 5.8 percent by December 2003. Eventually, the Central Bank could lower rates: by late 2003 the SELIC rate was reduced to 16.5, two points below its level before the crisis started.

Nevertheless, the 2002 shock had severe real consequences. Higher inflation and tight monetary policy in 2003 led to lower wages, reduced consumption, and zero (–0.2 percent) growth, driven by an export boom. In 2004, the economy showed signs of substantial recovery of wages, consumption, and output, and inflation was within the targets.

3. Chile: Policy Response to External Shocks

During the period 1990–2003, the Chilean economy grew at an average rate of 5.5 percent per year. The inflation rate fell from levels close to 30 percent in the beginning of the 1990s to single-digit levels by the end of 1994; thereafter it fluctuated around a steady-state level of 3 percent. External conditions played an important role in shaping the Chilean business cycle during this period. The terms of trade exhibited significant fluctuations, which were mainly determined by the evolution of the price of copper (the economy's main export) and oil prices. Additionally, the Chilean economy regained access to international capital markets during this period. Net private capital flows more than doubled between the late 1980s and mid-1990s. This access to external financing allowed an important boom in investment, which averaged 28 percent of GDP in the period 1995–98 (see table 1, as well as table A5 in the appendix).

Figures 6 and 7 show the relation between an index of external conditions (ECI) and GDP growth and the output gap, respectively.[17] The figures show a strong correlation between the ECI and the different measures of activity. Using the output gap measure, we distinguish one contractionary phase and one expansionary phase during the period 1990–2003. For the years 1990–98, the economy grew above potential, while in 1998–2003, the economy operated below potential. External conditions were particularly favorable in 1989, 1992, and 1995–1996. Nevertheless, a single external shock can be used to divide the whole period in these two clearly different phases: the Asian crisis and the associated events (see table 2). After a short period of improved conditions in 2000–01, another important external shock hit the Chilean economy when the major industrialized economies experienced a contraction in output in 2001–02, following the end of the asset price bubble in the United States and the terrorist attacks of September 11. Argentina and Brazil also underwent increasing pressure during this period, culminating in the collapse of the currency board in the former country, debt sustainability

17. The index of external conditions is constructed as a weighted average of the change in world interest rates, the change in terms of trade, and the GDP growth of commercial partners. The weights come from a regression among GDP growth, these variables, and other relevant variables to explain GDP growth. A panel of economists set up by the Ministry of Finance computes this output gap measure, which is used to estimate the structural fiscal surplus (see Marcel and others, 2001).

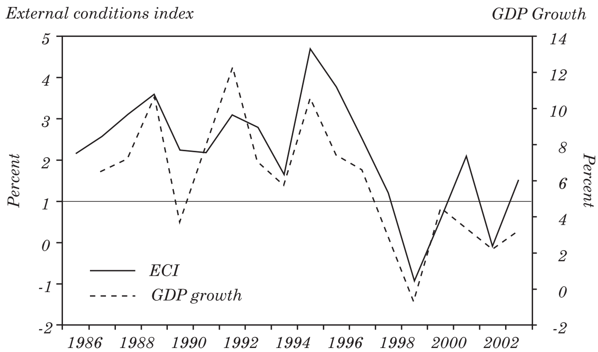
Table 1. Chile: External Conditions Indicators

Year	*Terms-of-trade growth (%)*	*Copper price*	*Oil price*	*Capital inflows to Latin America over GDP (%)*	*Trading partners' GDP growth (%)*	*Risk premium emerging markets (%)*	*Risk premium Chilean corporations (%)*	*U.S. Fed rate*
1990	–5.0	121.7	21.2	–8.4	2.9			8.1
1991	–0.5	104.0	15.8	–1.6	3.3	6.6		5.7
1992	–2.9	103.8	17.3	–2.4	2.5	6.7		3.5
1993	–3.7	86.1	14.4	4.9	2.1	6.3		3.0
1994	13.0	110.8	14.7	2.4	4.1	8.8		4.2
1995	14.1	133.4	16.2	4.6	3.0	12.2		5.8
1996	–13.2	101.4	19.0	2.0	3.1	7.0		5.3
1997	0.0	101.0	17.4	5.5	3.6	4.4	1.1	5.5
1998	–2.4	74.0	11.6	–3.5	2.4	8.8	2.4	5.4
1999	2.7	71.6	18.1	–13.8	2.7	9.8	2.7	5.0
2000	2.7	82.8	26.1	–22.7	3.8	8.1	2.5	6.2
2001	–4.7	70.8	22.7	–20.5	1.3	8.8	2.8	3.9
2002	3.4	71.7	24.8	–19.2	1.9	9.0	3.2	1.7
2003	2.8	83.2	26.5	–22.9	2.8	5.8	2.7	1.1

Sources: Central Bank of Chile; J.P. Morgan.

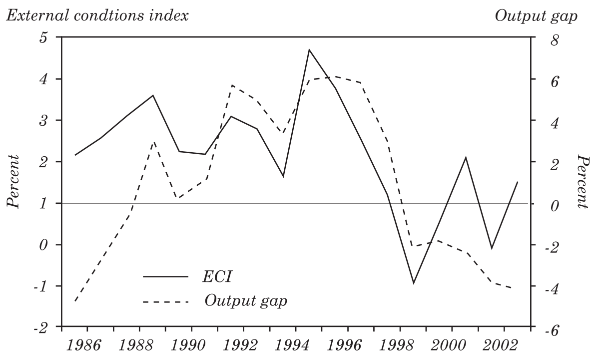
problems in the latter, and pressure on other emerging markets. In this section we study in detail the effects of these two shocks on the Chilean economy and the policy responses implemented in each case. Since the policy framework differed in both episodes, we describe the main components of the monetary policy framework at the time of each shock before analyzing the shock itself.

Figure 6. Chile: External Conditions Index and GDP Growth



Sources: Central Bank of Chile and authors' calculations.

Figure 7. Chile: External Conditions Index and Output Gap



Sources: Central Bank of Chile, Ministry of Finance of Chile, and authors' calculations.

Table 2. Main External Events, 1997–2002

Country	*Event*	*Date*
Thailand	Crisis and devaluation	July 1997
Russia	Devaluation and default	July 1998
Brazil	Speculative attack and devaluation	January 1999
United States	Technology stocks bubble burst	March 2000
Turkey	Speculative attack and devaluation	January 2001
Argentina	Political turmoil, speculative attack, and debt sustainability problems	February 2001
United States	Terrorist attacks	September 2001
United States	Accounting scandals	December 2001
Argentina	Devaluation and default	December 2001
Brazil	Elections	May–October 2002

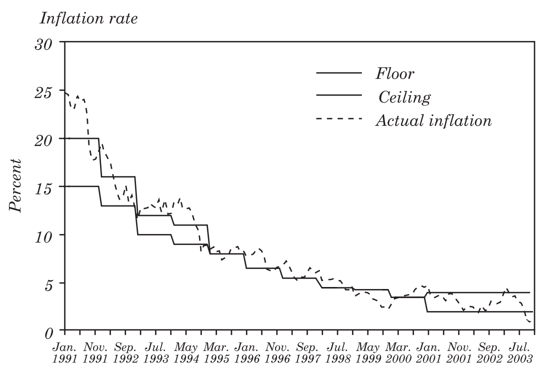
Source: Massad (2003b).

3.1 The Policy Framework in 1990–99

After being granted independence in 1989, the Central Bank of Chile, aiming at fulfilling its objective of price stability, pursued a quasi inflation-targeting regime until 1999. It moved into a full-fledged inflation-targeting regime in 2000. Inflation reached 27.3 percent in December of 1990, after major fluctuations in previous years. Probably the most basic components of the macroeconomic framework included annual quantitative inflation targets and the predominance of these targets as the nominal anchor of the economy, which eventually came into conflict with other nominal commitments. The announcement of these targets was probably the most symbolic characteristic of the regime, and it has led some authors to consider the Chilean experience of the 1990s as an inflation-targeting regime. Other typical features of this regime were absent, however. For instance, both the transparency and the communication devices of the regime fell short of what is regarded today as a prerequisite of inflation targeting (see table A1 in the appendix).

Annual targets for the December-December inflation rate for the coming year were announced in September of each year, in the Central Bank's annual report to Congress. This report strategically appears just one month before Congress begins debating next year's fiscal budget. In designing the inflationary objectives, the Central Bank first considered the goal of converging to single-digit inflation and, once that was accomplished, the final goal of achieving the level of inflation of developed countries—a level that was not precisely defined. The process explicitly included a slow convergence to lower inflation because of the prevalence of widespread backward-looking indexation in the Chilean economy. A rapid convergence to a low-inflation regime was considered risky because the key price misalignment that was likely to result would both produce real negative effects and jeopardize the disinflation program's sustainability. Only once in the eleven-year period was this annual announcement overridden during the course of the year: in 1995 the target was modified from 9 percent to 8 percent, in a policy decision closely related to the opportunistic approach to disinflation (see Dornbusch and Fischer, 1993). The initial inflation targets were defined as a target range, whereas point targets were used after 1995 (see figure 8).

Figure 8. Chile: Actual and Targeted Inflation



Source: Central Bank of Chile.

Given the date of the announcement and its focus on December of the coming year, the average life of the target in the 1990s was only seven and a half months—hardly a time span for monetary policy to have strong effects through the conventional transmission mechanisms. Rather, the announcements were a compromise between inflation forecasts, the need to lower inflation, and a well-developed communication strategy. The Central Bank was remarkably successful in bringing inflation down from 30 percent to less than 5 percent with this strategy.

There is no consensus on the precise reasons for this outcome. De Gregorio (2003) and García (2003) identify the positive productivity shocks faced by the economy throughout the 1990s as a key driving force of the inflation dynamics. Unit labor costs decreased despite indexation and declining inflation thanks to the unexpectedly high growth performance. Corbo (1998), Morandé (2001), and Schmidt-Hebbel and Werner (2002) identify the existence of the inflation target as a key coordinating device for expectations. They show that inflation dynamics changed substantially in the 1990s.

In addition to these annual inflation targets, the Central Bank managed a target band for the exchange rate. The band was perceived as the key instrument for achieving the objective of normal functioning of the external payments system, which in turn was implemented as a target (a cap) for the current account deficit. The exchange rate band was based on a purchasing power parity rule, corrected in some periods for productivity differentials between Chile and its trading partners. It underwent a number of modifications over the 1990s, including changes in its width and once-and-for-all realignments. The Central Bank intervened not only at the edges of the band, but also actively within it.

The Central Bank maintained important regulations on the capital account in the 1990s, including a nonremunerated reserve requirement for capital inflows (which was increasingly broadened until 1997) and a minimum stay for some inflows. These regulations were based on the desire to retain the possibility of managing the exchange rate with monetary policy autonomy and the intent to manage inflows to keep total expenditures under control.

The Central Bank's monetary policy conduct improved progressively throughout the 1990s. From a rather rough management of interest rates on a range of instruments in 1990, the Central Bank converged to managing liquidity to achieve a certain overnight interest rate in the interbank market. Foreign exchange interventions, in turn, were implemented in different ways, directly through foreign exchange purchases from public enterprises (mainly Codelco, the state-owned copper company) and indirectly through market operations. The publicly available information did not specifically indicate the exact extent and timing of interventions, as it jointly reported interventions and other international reserve movements—although interventions were clearly aimed at hindering the strong trend toward real exchange rate appreciation. The effort to sterilize inflows between 1990 and 1997 was a large one: during that period the Central Bank increased its foreign exchange reserve holdings from US$2.5 billion to US$17.8 billion. Its foreign exchange position switched from 5.1 percent of GDP short to around 25 percent of GDP long. In 1998 the Central Bank also intervened in the foreign exchange market by issuing dollar-linked debt and, briefly, using options.

Fiscal policy was managed in an orderly fashion in the 1990s, which allowed the central government's net public debt to decline from 37.6 percent of GDP in 1989 to 5.6 percent in 1997. The strong growth performance facilitated this result, but institutional factors also contributed. In fact, despite not having an explicit fiscal rule, Chile has strong fiscal institutions, including a centralized state (not a federal state), a strong Ministry of Finance within the government, and arrangements such as a copper stabilization fund that allows the authority to set aside abnormally high copper revenues in a transparent way.

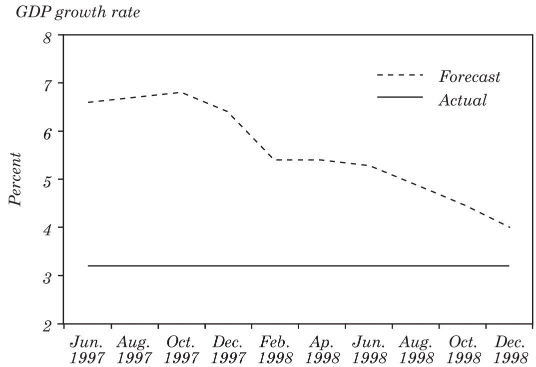
In addition to strong monetary and fiscal policies, the Chilean economy also displays strong financial institutions. The debt crisis in the 1980s, which led to the collapse of the banking system, triggered a substantial improvement in financial regulation and supervision. These changes supported the development of a healthy and resilient financial system.

3.2 The Asian and Russian Crises

By the beginning of 1997, the Chilean economy was experiencing an unprecedented growth phase. The economy grew at an average rate of 8.5 percent in 1991–96. Moreover, this rapid growth was achieved with inflation falling from 27 percent at the end of 1990 to 6.6 percent in December of 1996. In July 1997, Thailand devalued the baht; this event marked the beginning of the Asian crisis. In the months following this devaluation, many other countries in East Asia were forced to depreciate their currencies. Massive capital outflows, severe output losses, and widespread bankruptcy of banks and nonfinancial firms followed. The negative effects of these events were not restricted to Asian economies, but troubled many other emerging economies, as well.

Initially, the Asian crisis was expected to have an effect on the Chilean economy through real links, as close to 35 percent of Chilean exports were directed to these countries. These real effects were perceived to be limited, however. By December of 1997, GDP growth forecasts reported by consensus forecasts for 1998 were around 6.4 percent, only 0.3 percent down from those forecasts made in August 1997 (see figure 9). However, as the crisis developed, it became clear that its effects on the Chilean economy were not limited to real links, but also involved financial effects. Access to international capital markets for emerging economies, which was extensive for most of these countries in previous years, was severely restricted.

Figure 9. Chile: Actual and Forecast GDP Growth



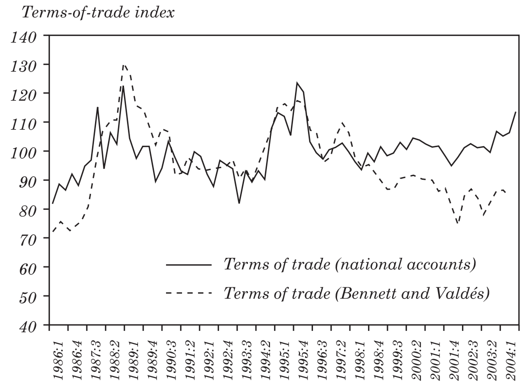
Sources: Central Bank of Chile and Consensus Forecast.

After suffering a fall of more than 13 percent in 1996, the terms of trade for the Chilean economy rebounded considerably in the first half of 1997, growing 5 percent in the first half of 1997 relative to the 1996 level, led mainly by the increase in the price of copper. However, the slowdown in world activity stemming from the Asian crisis generated a large fall in commodities prices in the second half of 1997. The price of copper fell more than 35 percent between July 1997 and June 1998. The fall in terms of trade was less dramatic, however, since the prices of the main Chilean imports were also falling. Between the second quarter of 1997 and the second quarter of 1998, the terms of trade fell nearly 3.5 percent.

Alternative measures of the terms of trade indicate that the fall may have been much larger than what the national account figures suggest. A methodology developed by Bennett and Valdés (2001) indicates that the terms of trade fell 15 percent from July 1997 to June 1998 (see figure 10).[18] Another measure that can be used to quantify the magnitude of the external shock faced by the economy is a weighted average of the changes in the terms of trade, the world real interest rate, and trade partners' growth (ECI). This index reached its highest value for the 1990s in 1995; it then decreased, and after 1998 it stayed below its average for the period 1985–2003.

18. These authors construct monthly price series for exports and imports using a Laspeyres methodology (that is, allowing for changes in the weight of the different components of the basket). Notably, the import price index is constructed using oil prices and the world import price index (adjusted by oil prices) constructed by the IMF.

Figure 10. Chile: Terms-of-Trade Indicators



Sources: Central Bank of Chile and Bennett and Valdés (2001).

A clear deterioration in the external conditions faced by the Chilean economy was thus perceived only at the beginning of 1998. Over the course of that year, it became clear that the external scenario was contractionary. The initial forecast for the price of copper of $0.96 for 1998 made by the Central Bank of Chile in September of 1997 was rapidly out of date. In January 1998, the price of copper reached its lowest value in four years, and by the end of 1998, it was at its lowest value since March 1987 (see table 3).

Initial conditions

The conduct of monetary policy in that uncertain environment was unquestionably difficult. Some domestic conditions made the task more complex, in particular the cyclical situation and the expansionary fiscal stance at the beginning of the adjustment period. By the second quarter of 1997, the Chilean economy was entering in a strong expansionary cycle of domestic demand. In the second half of 1997, household consumption grew at a rate of 10.5 percent, while investment growth was close to 14.0 percent. Central Bank estimates made at the beginning of 1998 indicated that the economy faced a potential deficit in the current account of nearly 8.0 percent in 1998. This was well above what the Central Bank considered appropriate to attain external sustainability.[19]

19. See “Evolución de la economía en 1999 y perspectivas para el 2000,” p. 14.

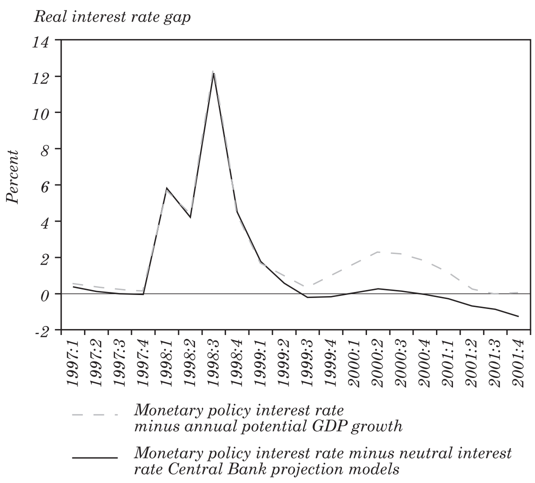
Table 3. Chile: External Conditions (Quarterly Indicators)

Year and quarter	*Terms-of-trade growth (%)*	*Copper price*	*Oil price*	*Capital inflows to Latin America over GDP (%)*	*Trading partners' GDP growth (%)*	*Risk premium emerging markets (%)*	*Risk premium Chilean corporations (%)*	*U.S. interest rate*
1997:1	–1.8	109.8	18.1	4.9	3.6	5.1	1.0	5.3
1997:2	3.4	118.5	17.3	7.2	3.8	4.0	1.1	5.5
1997:3	2.7	95.6	18.0	3.7	3.6	3.6	1.1	5.5
1997:4	–4.1	79.9	16.3	6.4	3.5	5.0	1.3	5.5
1998:1	–7.7	79.3	11.5	–0.7	3.2	4.5	1.7	5.5
1998:2	–3.3	75.3	11.7	–1.9	2.4	6.4	1.7	5.5
1998:3	–3.4	74.7	13.1	–7.4	2.2	12.9	2.4	5.5
1998:4	5.4	66.8	10.1	–4.2	1.9	11.2	3.6	4.9
1999:1	5.3	62.5	12.1	–7.9	2.2	10.3	3.1	4.7
1999:2	0.0	64.5	15.4	–11.2	2.3	10.2	2.6	4.7
1999:3	6.9	79.4	21.5	–18.1	2.7	10.9	2.8	5.1
1999:4	–1.0	80.0	23.5	–18.2	3.8	8.0	2.4	5.3
2000:1	6.2	78.9	25.1	–16.8	4.1	8.1	2.0	5.7
2000:2	4.5	79.5	27.3	–21.6	4.3	8.0	2.6	6.3
2000:3	–0.5	88.9	29.7	–25.8	3.8	7.6	2.5	6.5
2000:4	0.9	83.9	22.2	–26.8	2.8	8.6	3.0	6.5
2001:1	–2.6	78.9	23.4	–21.3	2.1	8.9	2.8	5.6
2001:2	–5.2	73.0	25.6	–24.1	1.4	8.1	2.8	4.3
2001:3	–7.3	64.7	24.0	–19.0	0.9	10.1	2.9	3.5
2001:4	–3.5	66.8	17.6	–17.6	0.7	8.0	2.9	2.1

Source: Central Bank of Chile.

The strong expansion in domestic demand in 1997 had a number of causes. In the first place, large capital inflows (close to 10 percent of GDP in 1997) played a crucial role. These capital inflows were the consequence of relatively high domestic interest rates and expectations of exchange rate stability. In addition, the public perception that potential GDP growth was around 7 percent fuelled a private consumption boom. The Central Bank of Chile and most private observers saw the strong growth in domestic demand as unexpected. In fact, the Central Bank gradually reduced real interest rates during 1997 from 7.5 percent early that year to reach 6.5 percent by December. Some analysts argue that this expansionary policy was one reason behind the domestic demand expansion. This claim is not convincing, however, after a close look to the data. If anything, the monetary policy seems to have been less contractionary at that time. Several measures for the neutral real interest rate confirm this view (see figure 11). Moreover, it is unlikely that the 1 percent change in the interest rate can significantly explain the magnitude of the expansion.[20]

Figure 11. Chile: Real Interest Rate Gap Measures

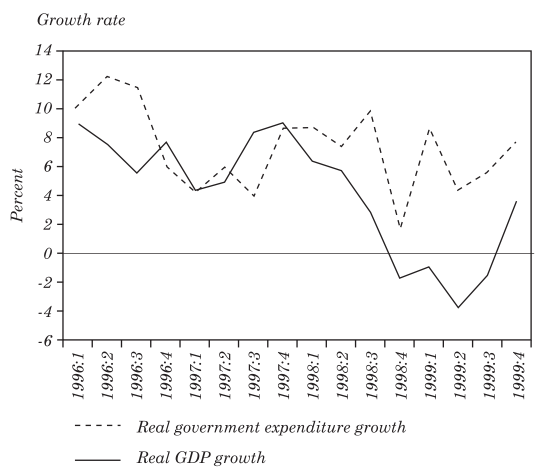


Source: Central Bank of Chile (Monetary Policy Report, May 2004).

20. However, if agents had at any time perceived this policy to be unsustainable given external conditions, it could have accelerated expenditures sizeably.

The second domestic condition that complicated monetary policy was an expansionary fiscal stance at the time of the external shock. Arguably, increasing an already positive fiscal balance in a booming economy would have been politically difficult, but the expansionary fiscal stance clearly contributed to the growth of domestic demand. Even at lower rates than private domestic demand, the inflationary effects of this type of expenditure could have had significant effects. The situation for 1998 was not different. The fiscal authority announced cuts in expenditures, but the delay in implementing these cuts made fiscal policy essentially expansionary in 1998 (see figures 12 and 13).

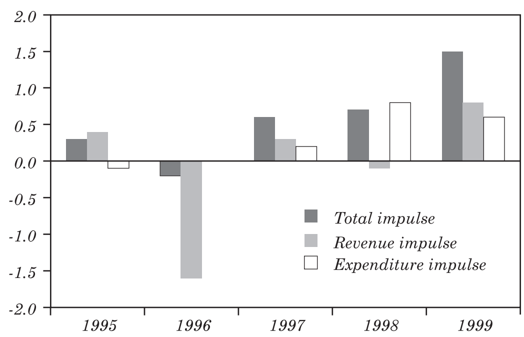
Figure 12. Chile: Government Expenditure and GDP Growth



Sources: Central Bank of Chile and Ministry of Finance of Chile.

Additionally, the minimum wage increased substantially in May 1998. The government set an increase in the minimum wage of 12.7 percent for 1998—and the path for this wage was set for a period of three years. The minimum wage thus increased 12.4 percent in 1999 and 10.4 percent in 2000. This policy translated into a significant increase in the real minimum wage, which may have reduced the labor markets' ability to deal with the negative external shock that the economy was facing. Moreover, average wages grew 2.5 percent in 1997 in an environment of highly persistent growth in wages stemming from indexation.

Figure 13. Chile: Fiscal Impulse



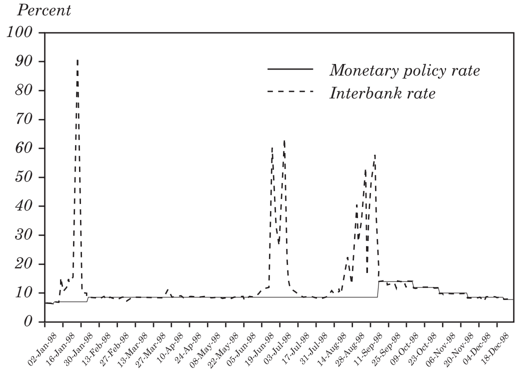
Source: International Monetary Fund.

Policy responses

At the end of 1997, the Central Bank of Chile intervened several times in the exchange rate market to avoid pressures toward the devaluation of the peso, which were associated with the uncertain external environment stemming from the unstable situation in East Asia. The fulfillment of the inflation target for that year was far from secured, and additional pressures from the exchange rate on inflation were not welcome. By the beginning of 1998, domestic demand was in a clear expansionary path, and the international scenario was becoming still more uncertain. The Central Bank therefore raised the interest rate by 50 basis point on 8 January. The authorities hoped that controlling internal demand would moderate the current account deficit to around 4 percent of GDP for 1998 and ensure the inflation target of 4.5 percent for December 1998.

Nevertheless, doubts persisted regarding the feasibility of the current account deficit target for the year. This triggered a first round of speculative attacks against the peso in mid-January. The intervention in the exchange rate market was implemented via nonsterilized interventions. As a consequence of this strategy, the interbank interest rate reached values over 90 percent in real annual terms at the end of January (see figure 14). The severe liquidity restriction raised the cost of the funds rate plus the spread above the maximum legal rate on some days in January, which meant that banks were unable to lend normally.

Figure 14. Chile: Monetary Policy Interest Rate and Interbank Rate



Source: Central Bank of Chile.

A new increase took place on 3 February. This time the Central Bank raised the monetary policy rate by 150 basis point. The associated press release explicitly stated that the increase in the interest rate was intended to bring the current account deficit to around 5 percent of GDP. This time, however, the Central Bank made it clear that it was targeting was the monetary policy rate.[21] The Central Bank stated that liquidity was going to be controlled to ensure the normal functioning of the financial system with no ceiling in the behavior of the interbank rate, which was to be determined by market forces.

Over the next few months, the Central Bank indicated that the interventions in the exchange rate market were implemented to smooth the fluctuations of the exchange rate. The authorities further clarified that it was impossible for the Central Bank of Chile to affect a natural tendency in the exchange rate.[22] Nevertheless, a new round of speculative attacks was underway by mid-June 1998. Increasingly bad news regarding the evolution of the Japanese economy, Chile's second largest trade partner, generated a climate of growing uncertainty. Doubts regarding the solvency of the Russian economy also intensified.

21. In its press release of 8 January, the Central Bank of Chile indicated that it was willing to take the necessary actions to keep the interbank rate around 7 percent in real annual terms. However, this interest rate was never close to that level in the second half of January 1998.

22. See *El Diario Financiero*, 5 July 1998.

The Central Bank intervened again in the exchange rate market while letting the interbank rate reach levels as high as 60 percent in real annual terms. In late June, the Central Bank announced a set of changes to the exchange rate regime and to the existing restrictions on capital flows (*encaje*). On June 25, it considerably reduced the width of the exchange rate band from a symmetric 12.5 percent around the center of the band to a +2.0 percent and –3.5 percent, eliminating also the tendency of the center of the band equal to 2 percent and maintaining its PPP adjustment.[23] The Central Bank also reduced the nonremunerated tax on capital inflows from 30 percent to 10 percent and started to issue dollar-denominated bonds. These actions were aimed at reducing volatility in the financial markets. By signaling a strong commitment with the inflation target for that year and providing hedging instruments for the financial system, the Central Bank was trying to decrease the pressure on the peso. These policy actions were not sufficient to reduce this pressure, however, which led to additional interventions in the exchange rate market and high interbank rates during the next few weeks.

A third round of speculative attacks took place in August and September 1998 amid devaluation expectations for many Latin American countries and the imminent debt default by the Russian Federation. The Central Bank intervened actively in the exchange rate market to avoid large movements in the exchange rate. The interbank interest rate again reached extremely high levels during this episode. In mid-September, the Central Bank announced a series of actions to reduce interest rate volatility and protect macroeconomic stability. These actions included raising the monetary policy rate to an unprecedented 14 percent in real annual terms and widening the exchange rate band to +/– 3.5 percent, followed by a gradual increase in the band from 3.5 percent to 5 percent by the end of 1998.[24] Some technical changes were also introduced in the way the center of the band was adjusted over time. Finally, the Central Bank announced the end of the nonremunerated tax (*encaje*).

Several factors motivated these policy actions. The Central Bank argued that "the true dilemma was how to manage the uncertainty, via the exchange rate or via interest rates."[25] In other words, the Central

23. The 2 percent tendency rate was toward recognising a real depreciation of the peso.

24. In December 1998, the Central Bank of Chile introduced a new modification to the exchange rate regime, increasing the bands to +/– 8 percent.

25. See "Evolución de la economía en 1999 y perspectivas para el 2000," p. 19.

Bank had to decide between letting the exchange rate depreciate or increasing interest rates to cool down domestic demand while sustaining the peso. The alternative of allowing the exchange rate to depreciate was considered dangerous because it could have unanchored inflation expectations (and ultimately effective inflation) because the inflation target for 1998 was not likely to be reached in that context. A devaluation of the exchange rate was expected to have a great impact on inflation given the degree of indexation of the Chilean economy. As the Central Bank stated, "Different estimations show a pass-through coefficient close to 50 percent after one year, which means that a depreciation of 10 percent translates into 5 percent extra inflation… The evidence shows that this coefficient is procyclical and could be 70 percent in a period in which the economy is growing beyond its potential, as in the second half of 1997… Moreover, this coefficient is higher if it operates through expectations and costs simultaneously."[26] Given the possibility of an exchange rate overshooting, the authority feared that being loose in the short term would have generated a severe loss of credibility, and that regaining it would have required tough policies in the future.[27]

The Central Bank also feared that a large devaluation could create problems in firms' balance sheets, given the mismatch generated by seven years of real appreciation (see Morandé and Tapia, 2002; Massad, 2003a). This could have affected the general perception of the Chilean economy. The Central Bank saw these actions as a way to help the private sector in the process of portfolio adjustment, by providing necessary dollars or reducing the private sector's exposure to the exchange rate. Finally, the Central Bank was concerned that the current account deficit would rise beyond a level considered sustainable, of around 4–5 percent of GDP. As mentioned before, the Central Bank justified part of the increase in the interest rate by the need to control the current account deficit. Levels above 6 percent of GDP were considered to have negative effects on the economy in the long run. In summary, the Central Bank held that the increase in interest rates to control the growth of domestic demand, the restriction of liquidity, and the exchange rate interventions allowed for an orderly exchange rate adjustment without risking financial and price stability.

26. See "Evolución de la economía en 1999 y perspectivas para el 2000," p. 17.

27. In 1997 effective inflation exceeded the target of 5.5 percent (December to December) by 0.5 percent. While this was a small margin, the monetary policy framework was strict regarding the annual fulfilment of the target (see Massad, 1998). As was made clear to the public, a revision of the 4.5 percent target for 1998 was impossible (see Massad's discussion in *El Diario Financiero*, 20 August 1998).

The mix of negative external shocks and the contractionary monetary policy resulted in GDP growth of 3.2 percent in 1998 and –0.8 percent in 1999. For these years, effective GDP growth rates were 2 percentage points and 4.5 percentage points lower than the respective projections made by the Central Bank in September 1998. At the same time, the inflation target was reached in the year 1998 (4.7 percent) while inflation in 1999 was 2 percent lower than the target fixed in September 1998. The current account deficit fell to 4.9 percent in 1998 and –0.1 percent in 1999.

Determining how much of the macroeconomic performance of the Chilean economy in that period can be attributed to policy and how much to the external scenario is a difficult task. Nevertheless, we can obtain some simple estimates of the monetary policy impulse by computing simple Taylor rules. Using the interbank real interest rate as the actual instrument for monetary policy in 1998, we find that the different specifications for Taylor rules, which include inflation differentials, output gaps, and the current account, cannot capture the magnitude of the increases in the real interest rate during the first three quarters of the year 1998 (see table 4).[28]

Table 4. Chile: Taylor Rules Estimations[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
Monetary policy rate (–1)	0.609	0.613	0.644
	(0.08)***	(0.06)***	(0.07)***
Inflation gap (–1)	0.165	0.154	0.128
	(0.08)**	(0.06)**	(0.07)*
Output gap (–1)	0.218	0.170	
	(0.03)***	(0.03)***	
Real exchange rate gap (–1)	0.076	0.085	0.073
	(0.02)***	(0.02)***	(0.03)***
Current account balance		-0.066	-0.145
		(0.04)*	(0.04)***
Dummy 1998:1	4.938	4.964	5.397
	(0.24)***	(0.22)***	(0.23)***
Dummy 1998:3	9.126	9.139	9.369
	(0.31)***	(0.27)***	(0.27)***
Dummy 1998:4	-3.624	-3.533	-3.614
	(0.91)***	(0.78)***	(0.83)***
Summary statistic			
R^2	0.97	0.97	0.96
No. observations	40	40	40

Source: Authors' calculations.
* Statistically significant at the 1 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 10 percent level.
a. Quarterly estimations, 1990:1–1999:4.

28. We thank Rodrigo Caputo for providing these estimates.

3.3 The Policy Framework since 2000

Chile began a substantial enhancement of its macroeconomic framework in 1999, partly in reaction to the 1997–98 shock and partly in response to the growing international consensus of the time. Five major changes are worth singling out: the adoption of a free-floating exchange rate regime; the deepening of the foreign exchange derivatives (forward) market; the implementation of a full-fledged inflation-targeting system; the introduction of an explicit fiscal policy rule for the central government; and the full opening of the capital account.

The gradual transition to a floating exchange rate was pursued with the widening of the exchange rate band in December 1998. Over ten months the band's width was increased from 7 percent to 16 percent of the central parity, and in September 1999 the Central Bank announced that the band was no longer part of the policy framework. The Central Bank officially retained the authority to intervene, but it announced that it would do so only in special circumstances, and it would inform the public about those decisions. Parallel to this slow transition to a floating regime—which remarkably did not entail any especially abrupt movement in the foreign exchange rate—the Central Bank made the regulatory adjustments necessary to foster the development of hedges. In particular, it eased banking regulations to allow banks to participate more actively in the forward market. Volumes increased rapidly. Total turnover volume in the derivatives market increased by 60 percent between 1998 and 2003, while the spot market more than doubled (see Alarcón, Selaive, and Villena, 2004).

The inflation-targeting framework was enhanced along several dimensions. In September 1999, an ongoing target band of 2–4 percent was announced as the new inflation target starting in 2001 (the interim target for December 2000 was 3.5 percent). The Central Bank began publishing an inflation report three times a year (the first issue was released in May 2000), announced monthly monetary policy meeting dates six moths in advance, and disclosed monetary policy meeting minutes with a three-month delay (which was subsequently shortened to three weeks). Overall, it markedly improved the disclosure of information, including detailed forecasts and views about transmission mechanisms. Procedural changes were enacted in a new Central Bank Board ruling.

With regard to fiscal policy, the new administration announced in 2000 that it would follow a rule for determining total expenditures over the next six years. The rule, known as the one percent structural surplus rule, aimed at ensuring a one percent surplus for the central government every year based on structural revenues, measured as cycle-adjusted tax revenues and what could be considered a normal copper price.[29] The one percent target was considered necessary to cover for the recurrent Central Bank deficit, to save copper wealth for future generations, and to insure against contingent liabilities.[30] The rule allowed the government to better communicate the fiscal position, to separate cyclical from structural changes, and, because it was accompanied by an important fiscal restraint, to improve credibility.

Lastly, the capital account was completely opened in 2001, although the Central Bank retained its faculty to impose restrictions. This move came after years of pursuing a strategy of gradual integration, which included a 30 percent unremunerated reserve requirement of one year for capital inflows (in force through 1998) and several other controls, such as a minimum stay requirement. This development was accompanied by a lowering of restrictions on the international allocation of funds managed by the private pension system.

3.4 The U.S. Recession and Global Uncertainty in 2001

After suffering a deep fall in GDP growth in 1999, the Chilean economy recovered in 2000 thanks to a positive external environment and the gradual normalization of monetary policy. The improvement in the terms of trade, which reached levels close to those observed in the years previous to 1996, and the strong economic expansion of commercial partners supported this recovery. After ending 1999 with the lowest annual inflation rate in decades, domestic prices started to increase steadily, explained mainly by the evolution of the oil price. Nevertheless, core inflation remained stable that year at around 3 percent .

The Central Bank decided to increase the real interest rate in January 2000 from 5.00 percent to 5.25 percent, based on two considerations: the economy was showing signs of becoming dynamic, which was expected to push up costs, and the possibility that oil price hikes might have been more persistent, which would have produced second-order effects on inflation. Although increases in aggregate demand remained within the limits expected by the Central Bank, oil prices fell more slowly than expected, leading the Central Bank to increase interest rates by an additional 25 basis points in March 2000. These policy adjustments were expected to be consistent with inflation rates within

29. See Marcel and others (2001) for details.
30. See Ministry of Finance (2000).

the target range in the one to two year policy horizon and with GDP growth around 6 percent for 2000 and 2001.

External conditions started to deteriorate, however, in the second half of 2000. The price of copper fell 27 percent between the third quarter of 2000 and the third quarter of 2001, while the price of other important export goods also fell. The terms of trade in goods and services fell almost 7.5 percent in this period. International credit conditions, which had remained tight in the previous periods, did not improve.[31] In addition, the GDP growth of trading partners reached 3.8 percent in 2000 and then embarked on a clear path of deceleration at the end of that year, finishing at only 1.3 percent in 2001. This fall was mainly explained by the drastic reduction in GDP growth in the United States from 3.8 percent in 2000 to 0.3 percent in 2001.[32]

The external scenario was deteriorating more rapidly than expected, which tended to push the balance of inflationary risks in a negative direction. The Central Bank therefore implemented a reduction in interest rate in August 2000. The Central Bank later reduced interest rates for a total of 100 basis points in the first three months of 2001 as inflationary expectations fall. The international scenario continued to worsen throughout 2001, while inflation expectations continued to fall. The Central Bank of Chile thus applied additional cuts in the interest rate, for a total reduction of 150 basis point in the first half of the year.

The worsening in world economic perspectives and the fragile position of some Latin American economies led the peso to depreciate almost 10 percent in two months (mid-June to mid-August).[33] Because the fast depreciation was generating excessive volatility, the Central Bank implemented a number of actions to provide domestic financial markets with hedging instruments and international liquidity. First, the Central Bank increased the supply of dollar-denominated bonds by US$2 billion in one year. Second, it assigned up to US$2 billion of international reserves to finance spot market interventions. Finally, it indicated that

31. Moreover, as the central banks of the main economies increased interest rates to head off inflationary pressures from the expansionary cycle, the risk premiums paid by emerging economies increased.

32. The sharp decrease in unemployment in the United States, the evolution of asset prices, and the significant increase in the U.S. current account deficit led the US Federal Reserve to initiate a process of steady increases in the Federal Funds interest rate. However, after technology asset prices collapsed in March 2000, news of a harder-than-expected landing of the U.S. economy emerged. This deceleration materialized in 2001. The September 11 attacks and the accounting frauds uncovered that year generated further uncertainty.

33. Moreover, the exchange rate suffered a depreciation of close to 10 percent between February and May 2001.

any monetary effect of these actions would be compensated in order to keep the provision of liquidity in pesos coherent with the monetary policy interest rate; this marked a clear divergence from previous intervention episodes.

The exchange rate market interventions were concentrated between September and October 2001 and involved around US$800 million (see Tapia and Tokman, 2004). These interventions involved fewer resources and were more effective than previous interventions. As Tapia and Tokman (2004) argue, the fact that these interventions were announced and explained to the public seemed to increase their effectiveness.

The combination of an expansionary monetary policy and adverse external conditions in 2001 resulted in GDP growth of 3.4 percent. This figure was 2 percentage points lower than expected at the end of 2000. Nevertheless, this external scenario was constructed with a 3.9 percent growth rate for the world economy, almost 2.5 percentage points less than the actual figure. Additionally, inflation rate remained low despite the fact that the nominal exchange rate devaluated 15 percent in 2001. The current account deficit increased from 1 percent in 2000 to 1.7 percent in 2001.

4. Conclusions and Policy Lessons

The design of policy regimes in medium-sized economies that are well integrated into the international trading system and that face large movements in their terms of trade or external financial conditions (or both) poses particular challenges. An evaluation of policy lessons must start with a description of an ideal setup—a first-best regime—based on the experiences of Australia, Brazil, and Chile. The first-best regime should include at least the following elements: a floating exchange rate that helps stabilize swings in the economy arising from the external sector; well-developed, liquid financial markets that allow financial institutions and firms to hedge risks arising from movements in financial prices (in particular, the exchange rate) and make the country less vulnerable to shocks; a credible medium-term inflation-targeting regime that anchors inflation expectations appropriately, but at the same time allows the central bank to respond flexibly to short-run movements in the inflation rate; and a sustainable and credible fiscal policy, with favorable public debt dynamics in the case of shocks.

These elements are interrelated and mutually reinforcing. For example, well-developed financial markets and a credible monetary policy regime are important in allowing exchange rate movements to play an effective, stabilizing role in the economy. While these interactions can be helpful, they can also pose significant complications in the adoption of a first-best regime, particularly for countries where the initial conditions are unfavorable.

A significant number of countries have adopted inflation targeting as their monetary framework. The three countries examined in this study represent three different points on the path to establishing such a regime. All three have embraced a floating exchange rate. Fiscal policy has improved markedly in both Chile and Brazil, but the latter still faces important challenge in reducing its debt-to-GDP ratio.

Despite the apparent framework similarities, the actual implementation of inflation-targeting regimes has differed across countries. Some countries, such as Chile in 1990–99, have implemented inflation-targeting regimes that combine inflation targets with targets for other macroeconomic variables such as the exchange rate or the current account. These multiple objectives have sometimes come into conflict with each another, which has heightened tension regarding the monetary policy framework and led to changes in the framework itself, generally in the direction of establishing the inflation rate as the only policy target.

The experience of the three countries suggests some lessons regarding the design of the regime and the challenges of implementation. These are discussed below.

4.1 Size of Shocks and How to Avoid Them

Each economy faced quite different magnitudes of shock, and the policy reactions are not easily comparable. However, shocks hitting economies cannot be interpreted as exogenous events over a longer horizon. The vulnerability to shocks reflects weak fundamentals and institutions, so they cannot be taken as exogenous in the long term. This means that learning how to respond to shocks is not sufficient. It is important to develop institutions to reduce the frequency and magnitude of shocks and not to delay reforms and adjustments.

For example, the crises in Brazil had severe real costs in terms of output, real wages, and consumption growth. In the short run, these crises may be considered as shocks: exogenous events that were beyond the control of policymakers and the country. In the long run, however they reflect the status of macroeconomic and institutional development. Over time, the presence of large and frequent external shocks generates instability in the economy; this maps into reduced credit ratings, among other problems. This may jeopardize the fulfillment of goals and targets, which may in turn hurt the country's credibility.

One can argue that the development of rules and institutions helps smooth political transitions and creates consensus for future reforms, which are essential ingredients for sustained growth. It takes time, however, to establish institutions and rules since they require credibility and are not disconnected from the culture of the country. In Chile, the fiscal rule implemented in 2000, which ensures a structural surplus, has allowed fiscal policy to be countercyclical. In the case of Brazil, good examples of recently created institutions and rules (some not completely established) are the fiscal responsibility law, inflation targeting, the floating exchange rate regime, and fiscal federalism. The degree of openness, flexibility, and respect of contracts have also improved.

4.2 Initial Macroeconomic Conditions

The set of available policies after a shock depends not only on the shock characteristics, but also on the initial macroeconomic conditions. Furthermore, policymakers' perceptions of certain key relationships will shape what kind of policy reactions are considered most appropriate. Distinguishing these conditions and characteristics is important for drawing lessons.

Inflation level

It is important to differentiate between a situation in which inflation is at its steady state and one in which the inflation rate is converging toward to its long-run level. The policy responses that we analyzed in the cases of Brazil and Chile (specifically during the Asian crisis) occurred when the inflation rate was converging to its long-run level. This created additional difficulties in handling the situation.

From an empirical perspective, there is evidence that the inflation level during a shock matters for policy responses. In fact, this may explain why Australia was able to implement a relatively more flexible regime, and why Brazil and Chile had to increase (decrease) interest rates more (less) during the Asian crisis (the U.S. recession). Using a simple regression analysis to study the changes in real deposit interest rates from the previous year for a group of inflation-targeting countries in 1998 and 2001, we found that the inflation rate at the beginning of the period and the difference between this inflation rate and the inflation target at the end of the period are positively correlated with the real interest rate change (see table 5).[34] This evidence is consistent with the view that an unexpected shock reduces the space for flexibility in countries with declining inflation targets. Additionally, the difference between the inflation rate and the target can be evidence of an unfavorable cyclical position (see below).

Table 5. Real Interest Rate Change[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Pass-through	0.072		0.078		0.052
	(0.02)***		(0.02)***		(0.03)*
Initial inflation		0.264			
		(0.12)**			
Initial inflation – Inflation				1.854	1.691
target end of period				(1.11)*	(1.00)*
Current account balance			0.228	-0.412	-0.285
			(0.37)	(0.24)*	(0.23)
Growth commercial partners			0.986		
			(0.47)**		
Terms-of-trade change			-0.143	-0.350	-0.297
			(0.13)	(0.18)*	(0.18)*
Summary statistic					
R^2	0.18	0.12	0.33		
No. observations	36	35	36	25	25

Source: Authors' calculations.
* Statistically significant at the 1 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 10 percent level.
a. Regressions 4 and 5 are three-stage least squares estimates. Pass-through measures taken from Chouhri and Hakura (2001) and Hausmann, Panizza, and Stein (2001).

Business cycle

The contrasting monetary policy responses of Australia and Chile to the Asian crisis also reflect the cyclical position of each economy. In Chile, for example, when the crisis occurred, inflation was above the Central Bank's announced target for 1998, and there were concerns

34. The countries considered in the analysis are Australia, Brazil, Canada, Chile, Colombia, the Czech Republic, Hungary, Iceland, Israel, Korea, Mexico, New Zealand, Norway, Peru, Poland, South Africa, Sweden, Switzerland, Thailand, and the United Kingdom. The dependent variable corresponds to the change in the real deposit interest rate in 1998 (2001) with respect to 1997 (2000), based on the World Bank's *World Development Indicators*. Hence, each country has two observations.

about excess demand growth and its implication for the current account deficit. In Australia, domestic growth was solid, but inflation was below the medium-term objective partly because of a previous appreciation of the currency. This difference in starting points contributed to the inflationary concerns resulting from the considerably greater depreciation in Chile than in Australia. In fact, based on the regression analysis mentioned above, we could argue that countries with greater deficits in their current accounts with respect to their long-run levels experience larger (smaller) increases (reductions) in their real interest rates (see table A1).

Pass-through from depreciation to inflation

Another difference that shapes the policy responses is the extent of actual and perceived pass-through of exchange rate changes to CPI inflation. In Chile, for example, a 10.0 percent depreciation of the exchange rate might be expected to add around 5.0 percent to the CPI within a year, whereas in Australia the figure is closer to 0.75 percent. This more pervasive pass-through, increased according to what was perceived, made the task of the Chilean authorities more difficult than that of their Australian peers. Again, our simple econometric work indicates that countries with higher pass-through experienced larger increases in the real interest rate in 1998 and 2001 than countries with lower pass-through (see table A1).

If pass-through is perceived as high, the central bank might be reluctant to use the exchange rate to accommodate the negative external shock. This policy action may lead to significant effects on the country's competitive stance. For example, when some of Chile's important trade partners experienced large depreciations during the Asian crisis, Chile's real exchange rate appreciated close to 4 percent between June 1997 and June 1998. Different estimations indicate that the magnitude of the real exchange rate misalignment was between 10 and 20 percent by mid-1998 (see Céspedes and De Gregorio, 1999; Calderón, 2004). This misalignment suggests that the inflationary fears from the nominal devaluation may have been overstated, as the empirical analysis demonstrates that real exchange rate misalignment may reduce the inflationary effects of the nominal devaluation significantly (see Céspedes and De Gregorio, 1999; Goldfajn and Werlang, 2000).

The extent of pass through has declined over time in all three of our country cases. One reason for this is the enhanced credibility of monetary policy. With inflation expectations well anchored, wage demands now show little movement in response to changes in the exchange rate. Moreover, price-setters often view at least some part of exchange rate movements as temporary, and they are thus prepared to absorb, for a time, changes in the cost of imported goods in their margins. This experience suggests a self-reinforcing mechanism: high credibility not only provides more flexibility, but also reduces pass-through. The flip side of this, of course, is that low credibility leads to high pass-through and little scope for flexibility even though the benefits of flexibility may be high.

Financial markets, mismatches, and fear of floating

In the first-best world, terms-of-trade or external demand shocks would be accompanied by movements in the exchange rate that help redistribute the burden of the shock. By and large, this happened in Australia, where exchange rate movements played an important stabilizing role. At times large movements in the exchange rate were somewhat uncomfortable, but overall they served the Australian economy well. Exchange rate depreciations, in particular, were clearly expansionary.

Exchange rate movements raised more concern in Chile and Brazil. This partly reflects their impact on inflation, as discussed above, but it also reflects the structure of balance sheets (of either the private or public sector) and the development of financial markets. A critical issue in this regard is the willingness of those outside the country to accept local currency liabilities. In Australia's case, foreigners have been willing to take on Australian dollar exposures, either directly through the bond or equity markets or indirectly through the derivatives markets. This has allowed the exchange rate to move considerably in response to external shocks without generating concern about the health of domestic balance sheets. In contrast, Chile and Brazil have much more difficulty borrowing at reasonable interest rates in their own currencies on global capital markets.

A flexible exchange rate arrangement may provide the right incentives to hedge the exchange rate risk. In Chile, a rigid exchange rate may have provided lower incentives to do so. Moreover, the authorities' commitment to the inflation target provided space for private agents to react to changes in the conditions that called for depreciation. A flexible exchange rate regime has the benefit of providing the right incentives to hedge exchange rate risk, but it requires the development of an efficient and liquid exchange rate derivatives market.

The role played by financial markets is crucial to understanding the effects of external shocks in less developed economies. If financial markets are shallow, the effects of external shocks on output, investment, and employment are magnified by the role played by balance sheets or the collateral of firms. Firms operating in less developed financial markets suffer large increases in risk premiums, which tend to reduce aggregate demand and may require a more expansionary policy. As explained previously, however, a more flexible response of monetary policy may undermine credibility in those less developed countries and reduce the scope for cuts in interest rates.

Fluctuations in the exchange rate or risk premiums (or both) can also cause corresponding fluctuations in the debt ratio, with more intense fluctuations for a larger share of dollar-denominated debt (see, for example, Céspedes, Chang, and Velasco, 2004). If the debt is perceived as unsustainable, the economy may fall into a vicious circle of further depreciation and further increases in the debt ratio. Monetary policy cannot work alone in such a situation: fiscal policy needs to adjust to the permanent change in the real exchange rate or risk premium. The lesson is that working toward deepening financial markets may reduce vulnerability to negative shocks and thus may help to increase the effectiveness of the inflation-targeting regime.

Fiscal policy

The possibility of implementing a flexible inflation-targeting regime also depends crucially on the implementation of a sustainable fiscal policy. Fiscal institutions or arrangements play a central role in guaranteeing the consistency and credibility of the inflation-targeting regime. As has been extensively argued, the excessively procyclical fiscal policies in developing countries are the consequence of weak and deficit-prone fiscal policies. In the recent cases of Australia and Chile, strong fiscal institutions allowed fiscal and monetary policy to play a stabilizing role. Brazil has started to develop fiscal arrangements that are oriented to increasing the sustainability of the fiscal debt. The Brazilian experience shows that monetary policy cannot work alone in the midst of a confidence crisis: fiscal policy needs to adjust to the permanent change in the real exchange rate or risk premiums.

4.3 Flexibility versus Credibility

As countries have accumulated experience with inflation targeting, they have tended to adopt flexible regimes, focusing more on medium-term outcomes than on the permissible variation of inflation in the short run. Theoretically, this shift offers policymakers the scope to tolerate greater year-to-year variation in inflation and could potentially increase economic stability without prejudicing the overall goal of sustaining a low average inflation rate.

In the first-best world, extra flexibility can be useful for dealing with external shocks and swings in the exchange rate.[35] For example, consider the case in which inflation is initially at the central bank's target, but then the terms of trade rise and the exchange rate appreciates considerably. Inflation might be expected to fall for a couple of years as lower import prices feed through into the CPI, before gradually picking up as a result of the income effects of the higher terms of trade. Under these circumstances, a strict approach to inflation targeting may require monetary policy to be eased initially, adding to the already expansionary effect of the higher terms of trade. Conversely, the central bank may need to tighten its policy in response to an exchange rate depreciation caused by an adverse external shock. In terms of overall welfare, such responses may well be suboptimal, in that they increase the volatility of growth without providing any benefit in terms of the average inflation rate. In contrast, a more flexible regime might allow the central bank to avoid easing in an expansionary environment or tightening in a contractionary environment, thus contributing to greater stability of both the economy and interest rates.

While such a flexible regime may be useful, it may come at a cost if credibility has not yet been built and communication is not ideal. In particular, it has the potential to weaken the credibility of the regime, especially if the private sector expects the central bank to use flexibility to avoid taking difficult decisions. For example, a decision not to increase interest rates in response to a depreciation may be perceived as a signal that the central bank lacks commitment to the regime. In Chile and

35. When the inflation target is strict (or short term), the exchange rate is the only instrument that allows the monetary authority to affect inflation dynamics in the short run. As has been documented extensively in the empirical literature, the effects of changes in monetary policy on the output gap—and through this on inflation—usually requires horizons longer than three quarters. Therefore, using the interest rate to control the evolution of the exchange rate in the short run has additional effects on activity in the medium term that must be taken into account.

Brazil, the announcement and achievement of annual inflation targets were very much part of the process of building credibility. Chile only moved toward a flexible regime with medium-term targets after it reached its long-term inflation rate and, presumably, established a credible reputation.

One view is that if inflation is above its steady-state level, clear and verifiable short-term targets are preferred when credibility is lacking, but more flexibility is permitted as credibility is established. The difficulty arises if the targets can only be achieved with a severe contraction of the economy or if they simply become unattainable because circumstances change. In such cases, the strict target could actually work to undermine the credibility and durability of the regime.

For example, when Brazil faced a sudden stop that called for a large devaluation, the Central Bank missed its inflation targets and let the exchange rate depreciate in order to accommodate the shock and avoid potentially large output losses. In contrast, when Chile was confronted with a large negative external shock in 1998, the authorities decided to adjust the interest rate to keep control of inflation.[36] The outcome of this policy was the fulfillment of the inflation target in 1998, a recession in 1999, and an inflation rate almost 2 percent lower than the target in 1999. The long-run benefits of the two policies are difficult to assess. However, in the case of Chile, the gains in credibility allowed the economy to move toward a more flexible inflation-targeting regime with well-anchored inflation expectations around the long-run level of 3 percent.

The Australian regime was not built on achieving tightly defined short-run targets. When the objective was initially articulated, there was considerable skepticism about the central bank's commitment to it. In particular, a number of commentators noted the absence of any institutional changes and the multiple objectives of the Reserve Bank of Australia set out in legislation. Moreover, the fall in inflation of the early 1990s was widely viewed as accidental, rather than the result of a deliberate action by the Reserve Bank of Australia. In this environment, the process of building credibility was evolutionary rather than revolutionary. One element in this process was the progressive upgrading of the quality and quantity of published material on the economy and the greater focus on inflation in the Reserve Bank

36. It can be argued that a point inflation target further reduced the monetary authority's flexibility in dealing with the external shock. Fear of floating was also a factor, owing to perceived foreign exchange mismatches in the corporate sector.

of Australia's public communication. An important period was the tightening cycle that commenced in the second half of 1994. At that point in time, inflation remained low although confidence that this would be maintained was rather weak. Somewhat to the market's surprise, the Reserve Bank began raising interest rates in August 1994. In total, rates were increased by 275 basis points over a five-month period to December 1994. Public communication was explicitly forward looking, emphasizing the need to control inflation so as to sustain growth over the longer term. The enhanced credibility of the Reserve Bank of Australia that arose partly out of this episode was evident in 1996 when, as interest rates were being cut, there was very little public comment that the cuts were politically motivated, as there had often been in the past. Another useful factor in building credibility was the fact that the regime and the target remained unchanged for more than a decade. Over this period, the Reserve Bank of Australia communicated essentially the same message about its goals and the way it operates, and the message became increasingly ingrained in the way the public thinks about monetary policy. There is little, if any, public discussion on the need to change the framework or the numerical objective.

In Brazil, inflation targeting (coupled with a floating exchange rate regime) helped absorb the severe shocks that hit the economy, while at the same time keeping inflation under control. The latter was an essential ingredient for producing the real exchange rate depreciation (as opposed to nominal depreciation only) and, therefore, the external adjustment. Following the depreciation, the Central Bank assessed the nature and persistence of the shock; it then built different inflation and output trajectories associated with different interest rate paths, and it chose the optimal path for output and inflation based on its aversion to inflation variability. If the shock is abnormally large or persistent, its inflationary effect may last more than a year, so the optimal inflation path may imply a twelve-month-ahead inflation above the previous annual target. In such a case it is neither possible nor optimal to blindly pursue the central point of the old target: the target should be adjusted to take into account the effects of the change in relative prices. Eventually, inflation must converge to its target path, albeit at longer horizons.

Of course, some credibility costs are always associated with breaching original targets. The decision to neutralize the shock over a longer horizon, based on an evaluation of the size and persistence of the shock, may lead to time consistency issues: too much accommodation in the short run leads to loss of credibility in the long run. Given the size of the shocks, however, a decision to keep the old target could also imply a loss of credibility because it might be considered unattainable.

Therefore, it is essential that the whole procedure be explained publicly in considerable detail, so that agents can effectively judge whether the size and persistence of the shock justify the decision taken by the central bank. Transparency, therefore, imposes enough discipline to avoid time-consistency issues. Nevertheless, agents find it difficult to evaluate the results conditional on the environment where policymakers operate.

The optimal degree of flexibility may also depend on the initial macroeconomic conditions. In the first-best world, countries with a high degree of pass-through probably stand to gain more from a flexible approach to inflation targeting than those with low pass through. Since these countries are likely to demonstrate more short-term volatility in their inflation rate, additional flexibility increases the probability that they will not be drawn into the type of suboptimal policy responses discussed above. Again, the difficulty arises where credibility is weak. In such cases, the needed flexibility cannot be used for fear of undermining confidence in the regime.

4.4 Responding within an Established Framework

An important element for any monetary policy framework to be useful is stability. Policy actions that are well understood by the public and are inserted within the framework are more effective than opaque policy actions, as they also operate through the expectations of private agents. Policy actions that are not consistent with the framework are likely to create uncertainty. Accordingly, policy changes or changes in the framework are likely to generate uncertainty and expectations of further adjustments.

The experience of the three countries in this matter is illustrative. Chile's changes to the exchange rate band in 1998 may have stirred expectations of further changes, while letting the interbank interest rate drift away from the announced target probably created uncertainty regarding the monetary policy direction. In the case of Brazil, part of the framework was being built as policymakers were facing the shocks (for example, how much to accommodate and the appropriate horizon in which inflation should converge to the target path). The policy reactions in Australia and in Chile in 2002 were part of the same framework, built in advance and, probably, well understood. The challenge, therefore, is to develop sufficiently resilient frameworks so that policy reactions can be predictable as a contingency.

APPENDIX
Supplementary Tables

Table A1. Inflation Targeting In Australia, Brazil and Chile: Main Characteristics

Characteristic	*Australia*	*Brazil*	*Chile*
Independence of Central Bank:			
Formal	Yes	No	Yes
Targets		No	Yes
Instruments		Yes	Yes
Absence of conflicts with other goals	Yes	Yes	Yes (previously: exchange rate band until Sept. 1999)
Price measure for inflation target	CPI , excludes cost of interest	CPI	CPI
Date of adoption	Jun-93	June 1999	Sept. 1990
Annual inflation at adoption of inflation targeting framework	1.0%	3.3%	17.0%
Target	Range: 2–3%	Range: 3–8% (2004); 2–7% (2005); 2.5–6.5% (2006)	Range: 2–4% (previously: point, 1995–99)
Time horizon of the inflation target	Medium run	Annual target	Medium run (previously: December to December)
Years of convergence since adoption to the steady state	-	-	9 years
Escape clauses	None	Framework to react to shocks	None
Transparency			
Publication of board minutes	No	Yes	Yes (since 2000)
Publication of inflation forecasts	Yes	Yes	Yes (since 2000)
Publication of inflation report	Yes	Yes	Yes (since 2000)
Accountability	Parliament	Finance Minister	Parliament

Sources: Massad (1998); Morandé (2001); Schmidt-Hebbel and Tapia (2002); Reserve Bank of Australia; Central Bank of Brazil.

Table A2. Australia, Brazil and Chile: Economic Indicators

*Indicator**	*Australia*	*Brazil*	*Chile*
Gross domestic product (PPP) per capita (U.S. dollars)	27,818	8,015	9,992
Financial markets depth			
Domestic credit provided by banking sector (% GDP)	93.9	64.8	77.6
Rule of law[a]	6.0	2.4	5.0
Foreign exchange turnover (% GDP)	19.1	2.0	8.2
Creditors right index[b]	3.0	1.0	2.0
Interest rate spread[c]	5.0	43.7	4.0
Risk premium on lending[d]	3.3	37.6	
Openness[e]	33.5	24.3	55.2
Net external debt (% GDP)	48.9	40.0	
External debt in local currency (% total)	27.5	0.0	0.0
Net public debt (% GDP)	5.3	57.6	14.5

Sources: IMF, World Economic Outlook; IMF reports; International Credit Risk Guide; World Bank, World Development Indicators; Bank for International Settlements.

a. Assessment of the tradition of law and order in the country on a scale from 0 to 6, with lower values representing a weaker tradition of law and order.

b. Minimum score of 0 represents weak creditor rights; maximum score of 4 represents strong creditor rights.

c. Lending rate minus deposit rate.

d. Prime lending rate minus the U.S. Treasury bill rate.

e. Sum of merchandise exports and imports divided by the value of GDP, all in current U.S. dollars.

* Period: 2001-2003.

Table A3. Australia: Main Macroeconomic Indicators

Year	*GDP growth (%)*	*Inflation (Dec.–Dec.) (%)*	*Investment rate (%)*	*Current account deficit to GDP (%)*	*Terms-of-trade growth (%)*	*Real exchange rate*	*Unemployment rate (%)*	*Government balance to GDP (%)*	*External debt to GDP (%)*
1990	1.8	7.3	22.3	5.2	–2.9	85.1	6.7	0.2	50
1991	–0.6	3.2	20.4	3.6	–9.6	86.2	9.3	–2.7	53
1992	2.0	1.0	21.5	3.6	–2.3	95.1	10.5	–4.7	56
1993	3.8	1.8	22.3	3.2	–6.3	101.6	10.6	–4.5	56
1994	4.9	1.9	23.5	5.0	–0.4	97.7	9.4	–3.5	56
1995	3.5	4.6	22.0	5.4	3.7	100.0	8.2	–2.1	53
1996	4.3	2.6	22.2	3.9	1.3	91.0	8.2	–0.9	56
1997	3.9	0.3	23.1	3.1	1.9	91.5	8.2	–0.1	57
1998	5.2	0.9	24.3	5.0	–3.2	103.4	7.7	0.3	61
1999	4.3	1.5	24.4	5.7	–5.0	101.6	6.9	0.9	63
2000	3.2	4.5	21.5	4.1	6.1	106.1	6.3	0.9	64
2001	2.5	4.4	22.3	2.4	4.1	110.1	6.7	–0.1	72
2002	3.8	3.0	24.1	4.3		104.0	6.3	–0.6	73
2003	3.0	2.8		6.0			5.9	–0.6	77

Sources: IMF, World Economic Outlook database.

Table A4. Brazil: Main Macroeconomic Indicators

Year	*GDP growth (%)*	*Inflation (Dec.–Dec.) (%)*	*Investment rate (%)*	*Current account deficit to GDP (%)*	*Terms-of-trade growth (%)*	*Real exchange rate*	*Unemployment rate (%)*	*Real wages growth (%)*	*Government balance to GDP (%)*	*External debt to GDP (%)*	*Sovereign debt to GDP (%)*
1990	–4.2	1621.0		0.8	–9.5	99.3	4.7		1.4	24.8	
1991	1.0	472.7	18.0	0.3	5.9	115.5	5.2		–0.2	26.0	777.0
1992	–0.5	1119.1	18.4	–1.6	2.0	130.7	6.1	7.15	–1.8	29.7	804.4
1993	4.9	2477.1	18.8	0.1	1.1	125.9	5.8	7.8	–0.8	33.0	961.4
1994	5.9	916.5	21.5	0.3	14.2	102.7	5.4	21.8	1.6	32.9	813.7
1995	4.2	22.4	20.7	2.6	11.1	89.4	5.0	11.8	–5.0	27.9	1.124.8
1996	2.7	9.6	19.3	3.0	–0.5	84.4	5.8	4.8	–3.4	22.8	694.4
1997	3.3	5.2	19.9	3.8	6.1	81.6	6.1	3.9	–4.3	23.4	451.3
1998	0.1	1.7	19.7	4.2	–1.6	83.3	8.3	–0.6	–7.4	24.5	819.7
1999	0.8	8.9	18.9	4.8	–13.2	123.5	8.3	–7.8	–3.4	30.6	1.099.9
2000	4.4	6.0	19.4	4.0	3.0	117.6	7.8	0.9	–1.2	46.0	754.1
2001	1.3	7.7	19.5	4.6	–0.3	140.7	6.8	–8.8	–1.4	39.7	906.6
2002	1.9	12.5	18.3	1.7	–1.4	152.4	11.68*	7.75*	0.0	44.5	1.402.8
2003	–0.2	9.3	18.1	–0.8	–1.4	153.0	12.31*	9.40*	–0.9	50.4	813.3

Sources: IMF, World Economic Outlook database; Central Bank of Brazil.
* IBGE changed its methodology in 2002.

Table A5. Chile: Main Macroeconomic Indicators

Year	*GDP growth (%)*	*Inflation (Dec.–Dec.) (%)*	*Investment rate (%)*	*Current account deficit to GDP (%)*	*Terms-of-trade growth (%)*	*Real exchange rate*	*Unemployment rate (%)*	*Real wages growth (%)*	*Government balance to GDP (%)*	*External debt to GDP (%)*	*Sovereign debt to GDP (%)*
1990	–4.2	1621.0		0.8	–9.5	99.3	4.7		1.4	24.8	
1990	3.7	27.3	18.8	1.6	–5.0	126.7	7.8	1.8	0.8	63.4	
1991	8.0	18.7	17.3	0.3	–0.5	122.6	8.2	4.9	1.5	51.8	
1992	12.3	12.7	19.5	2.1	–2.9	113.6	6.7	4.5	2.2	45.7	
1993	7.0	12.2	23.0	5.4	–3.7	114.5	6.6	2.1	1.8	45.0	
1994	5.7	8.9	21.8	2.9	13.0	110.6	7.9	4.4	1.6	43.5	
1995	10.6	8.2	27.7	1.9	14.1	100.0	7.3	3.8	2.4	33.8	
1996	7.4	6.6	27.4	4.1	–13.2	99.7	6.3	3.8	2.1	33.6	
1997	6.6	6.0	28.1	4.4	0.0	95.6	6.1	2.5	1.8	30.3	
1998	3.2	4.7	27.8	4.9	–2.4	97.7	6.3	2.7	0.4	41.3	
1999	–0.8	2.3	22.4	–0.1	2.7	106.5	9.8	2.9	–1.4	46.9	1.8
2000	4.5	4.5	24.4	1.0	2.7	111.7	9.2	0.8	0.1	49.1	2.0
2001	3.4	2.6	23.7	1.7	–4.7	128.3	9.1	1.4	–0.3	57.8	1.9
2002	2.2	2.8	24.1	0.8	3.4	132.7	9.0	2.2	–0.8	65.4	1.8
2003	3.3	1.1	24.2	0.8	2.8	136.5	8.5	0.8	–0.8	57.1	1.3

Sources: Central Bank of Chile; J.P. Morgan; IMF, *World Economic Outlook* database.

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Large Hoardings of International Reserves: Are They Worth It?

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Several Asian economies have accumulated large stocks of international reserves over the last few years. This motivates the question we address in this paper from an empirical point of view. Are these large increases in reserves an efficient crisis-prevention strategy? Or are they second-best to other options, such as improving governance and developing better institutions in the financial markets? The current literature does not reach a firm consensus. A number of studies argue that reserve accumulation reduces the likelihood of self-fulfilling speculative attacks.[1] Others, however, stress that reserve accumulation is a relatively costly self-insurance strategy. Moreover, reserve accumulation could also be a counterproductive strategy, while crises are likely to be deeper in the presence of weak financial systems.[2]

In this paper, we estimate a model to quantify the impact of international liquidity on the probability of a crisis. Our goal is to evaluate how robust reserves (or the lack thereof) are in explaining crises, in particular, after we control for the quality of political institutions and the soundness of the financial system. We then use our estimates to evaluate the optimal level of reserves from a cost-benefit analysis for a group of East Asian economies and for Chile.[3]

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1. See, for example, Sachs, Tornell and Velasco (1996); Chang and Velasco (1999); Jeanne and Wyplosz (2001).
2. These points are noted particularly in Caballero and Krishnamurthy (1999, (2000, 2001).
3. Recent research on related topics can be found in Aizenman and Lee (2005).

External Vulnerability and Preventive Policies, edited by Ricardo Caballero, César Calderón, and Luis Felipe Céspedes, Santiago, Chile.

Our results lead us to the conclusion that recent trends in reserve accumulation by some Asian economies seem a sensible approach to dealing with the current macroeconomic conditions in the world economy. The empirical evidence we present indicates that the probability of crisis is still strongly related to the ratio of reserves to short-term debt, even when we control for political and financial system variables. At the same time, the actual size of the reserve stock observed today is not far from what would be implied by the usual cost of a crisis.

Our work is framed around two existing strands of the literature on international reserves. The first strand is the role of reserves as an indicator for financial or currency crisis in the context of the early-warning-system literature.[4] Typically in this literature, an exchange market pressure variable is constructed combining increases in interest rates, the exchange rate, and rapid reserve depletion. This variable attempts to summarize the magnitude of speculative behavior over a wide range of possible policy responses and regimes, and it is therefore not restricted to specific circumstances, such as depreciations after periods of fixed exchange rates. An indicator variable is created that takes the value of one if exchange market pressure is above a specified crisis threshold. The second step in this procedure is to regress this indicator on a set of right-hand-side variables, which typically include the ratio of reserves to short-term debt and the misalignment of the real exchange rate. This framework should thus allow an observer of these variables to assess the likelihood of a currency crisis.

Although we follow the logic of this basic approach in our work, we extend the empirical methodology in two directions. First, we include different variables to capture the effect of financial depth on the likelihood of a crisis. We test whether a deeper, more liquid domestic financial system is related to a lower probability of crisis. Second, we include governance variables. Weak political institutions are prone to deal feebly with financial stress, as they do not have the correct incentives (because of corruption), they lack technical expertise, or their policy actions are not credible to market participants. Our results indicate that the effect of the ratio of reserves to short-term debt on crisis probability is robust to the inclusion of these two sets of variables, and the selected financial and political variables have an empirically ambiguous or weak relation with the probability of a crisis.

4. See Frankel and Rose (1996); Berg and Pattillo (1999); Sachs, Tornell, and Velasco (1996); Berg and others (1999). See also Kaminsky and Reinhart (1999).

The second strand of the literature on which we base our work is the standard model of reserves demand. We use a simple model that relates the optimal level of reserves to its opportunity cost and the expected cost of a crisis. By assuming reasonable values for the latter, we compute theoretical optimal levels for reserves and compare them to actual recent stocks held by a number of Asian countries and Chile. We find that for a crisis cost of between 5 and 15 percent of gross domestic product (GDP), the actual ratio of reserves to short-term debt in some of these Asian countries is below the optimal level derived from the model. At the same time, the implicit cost of a crisis that is consistent with the actual level of reserves held by those countries is in the range of a soft to mild crisis. These results, however, turn out to be very sensitive to the data used and the specification of the model for the crisis probability.

Our approach to explain reserve accumulation emphasizes the role of international liquidity as a tool for self-insuring against external shocks. Dooley, Folkerts-Landau, and Garber (2003, 2004) put forward an alternative explanation for the large reserve accumulation by East Asian economies. According to these authors, this large reserve accumulation—in particular, by China—corresponds, in part, to an export-oriented development strategy, by which governments attempt to systematically keep the real exchange rate undervalued by accumulating reserves. We do not explore this hypothesis in this paper.

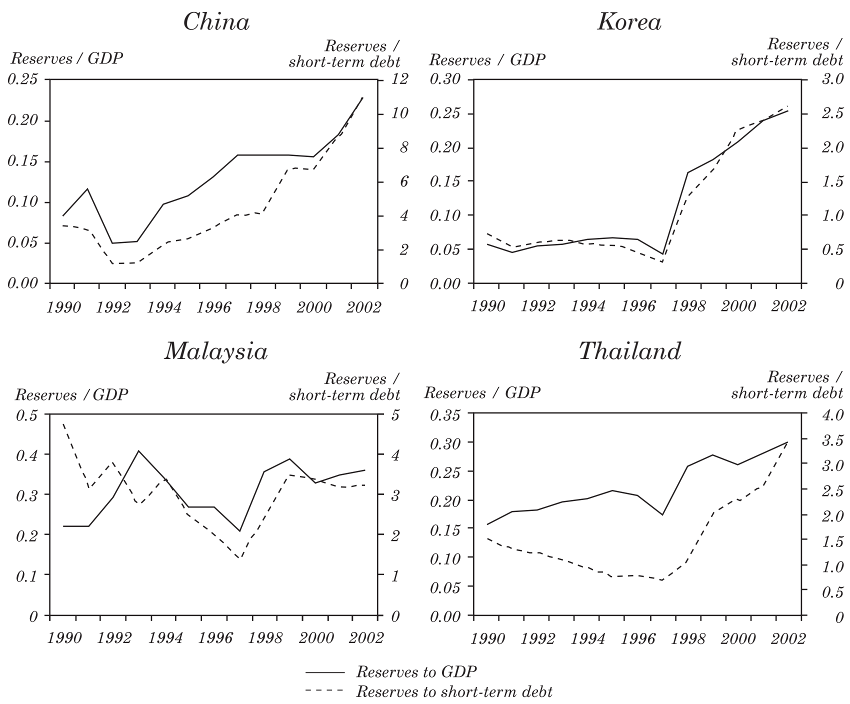
The paper is organized as follows. The next section describes some recent trends in reserve accumulation by emerging economies. Section two then presents the empirical methodology used to estimate the probability of a crisis and discusses the main results. Section three computes the optimal level of reserves for a selected group of Asian countries and for Chile. Finally, section four concludes.

1. Recent Trends in Reserve Accumulation

One of the most remarkable features of the recent trend in reserves is the large accumulation by East Asian economies. By the end of 2003, four East Asian economies (namely, China, Korea, Malaysia, and Thailand) held roughly 25 percent of world's total international reserves. These countries have systematically increased their reserve holdings over the last several years. Measured as a percentage of GDP, reserves in these four East Asian economies on average grew from roughly 10 percent at the end of the 1980s to nearly 30 percent in 2002. Reserves have increased not only relative to the size of those economies, but also relative to short-term external debt: the ratio of reserves to short-term external debt rose from 2.5, on average, for those four countries in 1990 to 5 by 2002.

These figures are heavily influenced by the trend followed by reserves in China, which increased from less than 10 percent of GDP in 1990 to more than 25 percent of GDP in 2002, and to a lesser extent by the trend in Korea and Thailand (see figure 1). Korea held a relatively constant fraction of GDP in reserves (about 5 percent) until the Asian crisis. After 1998, it dramatically increased its reserve holdings to 25 percent of GDP in 2002. Thailand systematically increased its reserves as a fraction of GDP throughout the 1990s. However, this country also received large capital inflows over these years—until the Asian crisis—so its ratio of reserves to short-term external debt actually felt from 1990 to 1998. After that year, reserves increased systematically, measured both as a fraction of GDP and relative to short-term external debt .

Figure 1. Reserves in four East Asian economies, 1990–2002

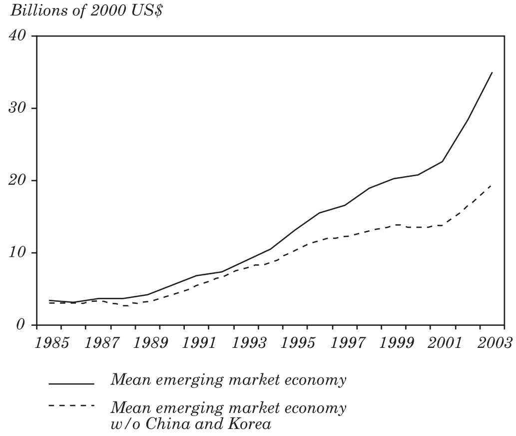


Source: Authors' calculation based on IFS/BIS data.

Malaysia held a relative large stockpile of reserves in the 1990s, measured both as a fraction of GDP (30 percent on average) and relative to short-term external debt (more than twice its stock of short-term external debt, on average). Both ratios fell before the Asian crisis but have grown since.

East Asian economies are not the only countries to have accumulated large amounts of international liquidity. Emerging market economies, in general, have followed a similar pattern, though to a lesser extent (figure 2). Reserves in emerging market economies grew from approximately 5 percent of GDP at the end of the 1980s to 16 percent in 2002 (figure 3).[5] When measured with respect to short-term external liabilities, reserves in emerging market economies also increased systematically after the early 1990s, despite the large capital inflows to those economies during this period. The ratio of reserves to short-term debt in emerging market economies rose, on average, from approximately 1 in 1990 to 2.4 in 2002 (see figure 4).

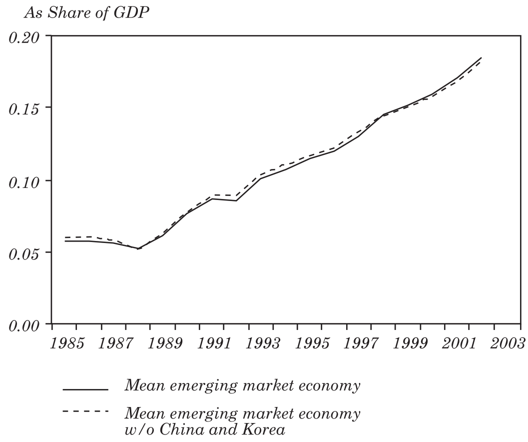
Figure 2. Real Reserves in Emerging Market Economies



Source: Authors' calculations based on IFS data.

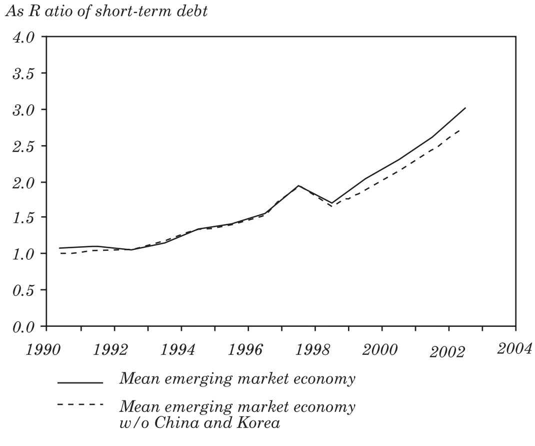
5. In contrast, developed economies have maintained a relatively constant ratio of reserves to GDP of about 6 percent since the mid-1980s.

Figure 3. Reserves in Emerging Market Economies as a Share of GDP



Source: Authors' calculations based on IFS data.

Figure 4. Reserves in Emerging Market Economies as Ratio of Short-Term Debt



Source: Authors' calculations based on IFS/BIS data.

2. Reserve Accumulation and Crisis Probability

Recent literature on international crises emphasizes the role of international reserves in preventing financial or currency crisis.[6] Rather than serving as a buffer to absorb transitory current account shocks—(as was emphasized in the literature on reserve adequacy in the 1950s and 1960s), reserves are now perceived as a tool for reducing both the frequency and the impact of international crisis. This role of international reserves has been widely analyzed, both theoretically and empirically. However, the quantitative contribution of reserves to reducing the risk of a crisis has only recently been addressed. Bussière and Mulder (1999), for example, find that the ratio of short-term debt to reserves is significant in predicting a crisis. They also quantify how much liquidity (reserves) countries should have to counteract weak fundamentals and avoid a crisis. In this section, we follow the early-warning-system literature to quantitatively estimate the robustness of the contribution of reserves in reducing the probability of an international crises.

2.1 Empirical Approach

The literature usually posits a specification that relates the probability of a crisis to the ratio of reserves to a selected scaling variable and a number of other controls. Consistent with recent theoretical emphasis on liquidity to explain crisis, we consider as a scaling variable the short-term debt of the country.

For the sake of simplicity, we denominate $p_{i,t}$ the probability of a crisis in country i at time t, and we assume that it is a function of a linear combination of the ratio of reserves to short-term debt at the beginning of period t, $R_{i,t} / S_{i,t}$, the total debt to GDP ratio, $D_{i,t} / Y_{i,t}$, another set of variables contained in vector $\mathbf{Z}_{i,t}$, and a crisis shock, $\varepsilon_{i,t}$:

$$p_{i,t} = p\left(\beta_0 \frac{R_{i,t}}{S_{i,t}} + \beta_1 \frac{D_{i,t}}{Y_{i,t}} + \mathbf{Z}_{i,t}\gamma - \varepsilon_{i,t}\right). \tag{1}$$

In this formulation the ratio of reserves to short-term debt is a measure of the liquidity of the economy, and the ratio of total debt to GDP is a proxy for solvency. Therefore, $\beta_0 < 0$ and $\beta_1 > 0$.

6. The theoretical literature includes, for example, Calvo (1996), Chang and Velasco (1999), and Jeanne and Wyplosz (2001).

We estimate the crisis probability based on a panel of countries with yearly observations. To define a crisis episode, we use the standard measure of exchange market pressure (EMP), by constructing a weighted average of the first differences in the real exchange rate, and the level of reserves,[7]

$$\mathrm{EMP}_{i,t} = \omega_{rer} \frac{\mathrm{RER}_{i,t} - \mathrm{RER}_{i,t-1}}{\mathrm{RER}_{i,t-1}} + \omega_R \frac{R_{i,t} - R_{i,t-1}}{R_{i,t-1}}, \tag{2}$$

where $\mathrm{RER}_{i,t}$ is the average real exchange rate of country i in year t, and $R_{i,t}$ is the level of reserves (real) at the end of year t. Weights correspond to the inverse of the variance of each variable for all countries over the full sample. A crisis episode occurs in period t in country i if $\mathrm{EMP}_{i,t}$ exceeds a predetermined threshold value, $\bar{X}$. In particular, we define a crisis index as follows:

$$Y_{i,t} = \begin{cases} 1 & \text{if } \mathrm{EMP}_{i,t} > \overline{\mathrm{EMP}}_i + 2\mathrm{SD}(\mathrm{EMP}_i) \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

In this framework, the crisis probability corresponds to the probability of the event $Y_{i,t} = 1$. This probability cannot be measured ex ante, as only the effective ex post occurrence of crises can be observed. Moreover, the latter hinges on the particular definition of the threshold value, $\bar{X}$. For the sake of our main argument, we abstract from these considerations for now, and assume that a well-defined function relates macroeconomic variables to this probability of crisis for country i in period t:

$$\Pr(Y_{i,t} = 1) = F\left(\beta_0 \frac{R_{i,t}}{S_{i,t}} + \beta_1 \frac{D_{i,t}}{Y_{i,t}} + \mathbf{Z}_{i,t}\gamma - \varepsilon_{i,t}\right). \tag{4}$$

Equation 4 indicates that the probability of a crisis occurring in period t is a nonlinear function, F, of a linear combination of the ratio of reserves to short-term debt and other variables included in vector $\mathbf{Z}_{i,t}$, such as the deviation of the real exchange rate from its fundamental or long-run value, GDP growth, and the exchange rate regime.

7. Bussière and Fratzscher (2002) use a similar measure, but they also consider pressures absorbed by interest rate movements. In our case, we cover a longer time span, and incorporating interest rate movements would have decreased the data significantly. Other works that use a similar crisis indicator are Kamin and Babson (1999) and Kruger, Osakwe, and Page (1998).

For the empirical application, we assume that F is a logistic function. In other words,

$$p_{i,t} = \frac{\exp\left(\beta_0 \dfrac{R_{i,t}}{S_{i,t}} + \beta_1 \dfrac{D_{i,t}}{Y_{i,t}} + \mathbf{Z}_{i,t}\gamma - \varepsilon_{i,t}\right)}{1 + \exp\left(\beta_0 \dfrac{R_{i,t}}{S_{i,t}} + \beta_1 \dfrac{D_{i,t}}{Y_{i,t}} + \mathbf{Z}_{i,t}\gamma - \varepsilon_{i,t}\right)}. \qquad (5)$$

2.2 Quantifying the Effect of Reserves on Crisis Probability

This subsection presents benchmark estimates of crisis probability. Estimations were made using a logit model with yearly observations for the period 1975–2003. These estimates clearly highlight two of the results found in the literature, despite the lower frequency of our data and the longer time span. First, a low ratio of reserves to, among other measures of liabilities, short-term external debt, by the end of a year, increases the probability of a crisis in the subsequent year. Second, a large deviation of the real exchange rate from trend in a given year increases the probability of crisis in the subsequent year. The magnitudes involved are large.

Tables 1 through 3 present the results of a number of estimates using three scaling variables for reserves. Tables 1 and 2 present the results using short-term debt from different sources, while table 3 uses total external debt.[8]

Short-term debt is usually chosen as the scaling variable for reserves in crisis models. In circumstances of financial stress, however, a liquidation of assets held by investors (both local and foreign) need not be constrained to their holdings of short-term external debt. Domestic agents can liquidate their own holdings of money (a central bank liability), while holders of external debt can attempt to shift their portfolio away from all external liabilities. This justifies trying other definitions of the relevant scaling variables for reserves.

8. The data on short-term debt are from the Bank for International Settlements (BIS) and the World Bank's *World Development Indicators* database. The main difference between the two sources is that the BIS data include not only debt with maturity of up to one year, but also amortizations due within the year. Unfortunately, this database starts in the 1990s and is available only for emerging economies.

Table 1. Benchmark Estimation of Crisis Probability, with Liquidity Measured as Reserves to Short-Term Debt: BIS Data[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
REER MIS	–5.389	–5.638	–9.107	–8.91	–5.458	–5.763	–9.159	–8.97
	(3.88)**	(3.89)**	(4.69)**	(4.65)**	(3.82)**	(3.84)**	(4.56)**	(4.44)**
OPEN	1.584	2.603	3.192	3.592	2.148	3.317	3.461	4.015
	(0.90)	(1.55)	(1.77)*	(2.03)*	(1.18)	(1.88)*	(1.89)*	(2.21)*
R/STD	–0.391	–0.438	–0.504	–0.573	–0.468	–0.55	–0.529	–0.62
	(1.90)*	(1.88)*	(2.01)*	(1.97)*	(2.07)*	(2.11)*	(2.07)*	(2.04)*
TD/GDP	–0.336		–1.609		–0.416		–1.57	
	(0.42)		(1.91)*		(0.52)		(1.89)*	
CRED	0.313	0.318	0.512	0.528	0.438	0.478	0.572	0.611
	(1.08)	(1.08)	(1.24)	(1.26)	(1.42)	(1.50)	(1.34)	(1.39)
PUB. DEBT		–1.206		–2.153		–1.32		–2.102
		(1.22)		(2.21)*		(1.31)		(2.18)*
Growth			–14.83	–13.593			–14.332	–12.858
			(4.07)**	(3.85)**			(3.86)**	(3.55)**
Exports					–3.17	–3.885	–1.915	–2.583
					(1.69)*	(1.97)*	(0.98)	(1.25)
FIX	1.688	0.928	2.348	1.595	1.767	1.029	2.299	1.54
	(1.69)*	(0.85)	(2.23)*	(1.39)	(1.74)*	(0.93)	(2.21)*	(1.35)
MANAGED	0.737	0.557	0.888	0.792	0.697	0.534	0.761	0.656
	(0.90)	(0.68)	(1.06)	(0.94)	(0.84)	(0.65)	(0.91)	(0.78)
FLOAT	0.828	0.78	0.829	0.783	0.791	0.736	0.778	0.736
	(0.99)	(0.93)	(0.94)	(0.88)	(0.94)	(0.87)	(0.89)	(0.84)
Constant	–3.946	–3.771	–3.436	–3.445	–3.799	–3.626	–3.34	–3.348
	(4.25)**	(4.17)**	(3.71)**	(3.78)**	(4.02)**	(3.91)**	(3.60)**	(3.64)**
Summary statistic								
Pseudo R^2	0.13	0.14	0.24	0.24	0.15	0.16	0.24	0.24
No. observations	512	480	511	479	506	474	505	473
No. crisis	24	23	24	23	24	23	24	23

Source: Authors' calculations, based on data from the Bank for International Settlements (BIS).
** Statistically significant at 1 percent.
a. Absolute value of z statistics are in parentheses. See appendix for definition of explanatory variables.

Table 2. Benchmark Estimation of Crisis Probability, with Liquidity Measured as Reserves to Short-Term Debt: World Bank Data[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
REER MIS	–5.09	–5.095	–5.686	–5.722	–5.104	–5.101	–5.662	–5.684
	(5.99)**	(5.98)**	(6.12)**	(6.12)**	(5.84)**	(5.82)**	(6.02)**	(6.01)**
OPEN	0.278	0.639	0.026	0.287	0.427	0.757	0.107	0.35
	(0.21)	(0.48)	(0.02)	(0.21)	(0.31)	(0.57)	(0.08)	(0.26)
R/STD	–0.267	–0.291	–0.245	–0.257	–0.271	–0.291	–0.245	–0.256
	(1.89)*	(2.03)*	(1.78)*	(1.84)*	(1.91)*	(2.03)*	(1.76)*	(1.82)*
TD/GDP	–0.013		–0.362		–0.01		–0.303	
	(0.02)		(0.69)		(0.02)		(0.58)	
CRED	0.143	0.152	0.339	0.36	0.239	0.248	0.383	0.4
	(0.55)	(0.58)	(1.24)	(1.31)	(0.90)	(0.93)	(1.39)	(1.44)
PUB. DEBT		–0.499		–0.881		–0.464		–0.781
		(0.77)		(1.34)		(0.72)		(1.19)
Growth			–5.918	–6.154			–5.368	–5.597
			(3.20)**	(3.30)**			(2.86)**	(2.95)**
Exports					–2.197	–2.183	–1.452	–1.379
					(2.10)*	(2.10)*	(1.36)	(1.28)
FIX	0.771	0.692	0.914	0.849	1.002	0.927	1.035	0.969
	(1.21)	(1.08)	(1.43)	(1.32)	(1.54)	(1.42)	(1.59)	(1.48)
MANAGED	–0.002	–0.014	–0.103	–0.1	0.048	0.033	–0.082	–0.083
	(0.00)	(0.04)	(0.25)	(0.24)	(0.12)	(0.08)	(0.20)	(0.20)
FLOAT	0.513	0.531	0.286	0.306	0.524	0.538	0.309	0.327
	(1.24)	(1.28)	(0.67)	(0.71)	(1.25)	(1.29)	(0.72)	(0.76)
Constant	–3.133	–3.006	–2.608	–2.517	–3.137	–3.015	–2.657	–2.566
	(6.04)**	(6.10)**	(4.89)**	(4.99)**	(5.93)**	(5.99)**	(4.90)**	(5.01)**
Summary statistic								
Pseudo R^2	0.17	0.17	0.2	0.2	0.18	0.18	0.2	0.2
No. observations	897	897	874	874	891	891	868	868
No. crisis	55	55	54	54	55	55	54	54

Source: Authors' calculations, based on data from the World Bank's *World Development Indicators*.
* Statistically significant at 10 percent.
** Statistically significant at 1 percent.
a. Absolute value of z statistics are in parentheses. See appendix for definition of explanatory variables.

Table 3. Benchmark Estimation of Crisis Probability, with Liquidity Measured as Reserves to Total Debt: World Bank Data[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
REER MIS	–4.6	–5.147	–7.277	–5.674	–4.551	–5.174	–7.231	–5.668
	(3.61)**	(6.07)**	(4.26)**	(6.12)**	(3.44)**	(5.94)**	(4.17)**	(6.04)**
OPEN	0.985	0.565	1.178	–0.067	1.213	0.668	1.36	0.067
	(0.56)	(0.43)	(0.67)	(0.05)	(0.68)	(0.51)	(0.77)	(0.05)
R/TD	–2.58	–3.15	–1.952	–2.476	–2.716	–3.228	–2.072	–2.592
	(1.45)	(2.50)*	(1.04)	(1.97)*	(1.49)	(2.50)*	(1.10)	(2.01)*
STD/TD (BIS)	0.856		1.271		1.062		1.341	
	(1.03)		(1.46)		(1.23)		(1.50)	
CRED	0.329	0.125	0.49	0.307	0.428	0.214	0.53	0.349
	(1.13)	(0.48)	(1.33)	(1.12)	(1.39)	(0.82)	(1.41)	(1.27)
STD/TD (World Bank)		1.857		1.977		1.75		1.803
		(1.22)		(1.30)		(1.15)		(1.18)
Growth			–11.613	–5.291			–11.183	–4.765
			(3.65)**	(2.91)**			(3.48)**	(2.59)**
Exports					–2.471	–2.153	–1.427	–1.51
					(1.37)	(2.05)*	(0.76)	(1.40)
FIX	2.236	0.977	2.731	1.099	2.319	1.247	2.691	1.254
	(2.05)*	(1.47)	(2.39)*	(1.66)*	(2.08)*	(1.83)*	(2.35)*	(1.85)*
MANAGED	1.251	0.108	1.489	0.02	1.264	0.159	1.399	0.041
	(1.43)	(0.26)	(1.65)*	(0.05)	(1.42)	(0.39)	(1.56)	(0.10)
FLOAT	1.153	0.602	1.078	0.39	1.16	0.612	1.052	0.413
	(1.26)	(1.45)	(1.14)	(0.91)	(1.26)	(1.46)	(1.12)	(0.96)
Constant	–4.478	–3.443	–4.656	–3.156	–4.448	–3.416	–4.566	–3.138
	(4.52)**	(6.44)**	(4.63)**	(5.94)**	(4.40)**	(6.32)**	(4.53)**	(5.82)**
Summary statistic								
Pseudo R^2	0.12	0.17	0.2	0.2	0.13	0.18	0.2	0.2
No. observations	512	897	511	874	506	891	505	868
No. crisis	24	55	24	54	24	55	24	54

Source: Authors' calculations, based on data from the World Bank's *World Development Indicators*.
* Statistically significant at 10 percent.
** Statistically significant at 1 percent.
a. Absolute value of z statistics are in parentheses. See appendix for definition of explanatory variables.

In tables 1 and 2 the coefficient of reserves to short-term debt is statistically significant at 10 percent in all specification. In table 3 (using total external debt), half the specifications lead to a statistically significant estimate for the effect of the ratio of reserves to total debt. Moreover, the exchange rate deviation from trend is statistically related to the probability of a crisis in essentially all the specifications in all three tables.

We expanded these basic estimates with a number of other variables that are included in the literature. The effect of the inclusion of these variables, as well as their estimated impact, is discussed in what follows.

The effect of different measures of liabilities

Including as an additional explanatory variable the total stock of external debt, as a percentage of GDP, does not affect either the size or significance of the impact of the ratio of reserves to short-term debt and exchange rate deviations from trend in tables 1 through 3. It also does not appear to significantly affect the probability of a crisis.

In table 3, the inclusion of the structure of external debt similarly does not have a significant impact. However, if the ratio of reserves to total debt is used instead, then the estimated coefficient is an order of magnitude larger than the coefficient on the ratio of reserves to short-term debt in previous specifications.

This result must be interpreted with caution, as it is a product of the scaling of the variables and not a marginal contribution to the crisis probability. When we also incorporate the structure of external debt, the ratio of short-term to long-term debt appears to increase the crisis probability, but not with a statistically significant coefficient.

Economic growth and credit booms

Economic growth, measured as both aggregate GDP growth and export growth, appears to strongly influence the probability of a crisis in the expected way. This can stem from a number of causes. A fast pace of economic growth can reduce the demand for publicly provided assistance programs and allow for increased tax revenue over the cycle, while fast export growth, given domestic demand growth, reduces the current account deficit. Including both export growth and GDP growth indicates that the latter is the most significantly related to crisis probability.

Domestic credit expansion, on the other hand, has a positive impact on crisis probability. However, it is not statistically significant at conventional levels.

External conditions

In principle, one should expect that crises would be more likely whenever external conditions deteriorate. Declining terms of trade, an increase in international interest rates, and the interaction of the latter with the outstanding stock of external debt should make for difficult circumstances.

However, the results from our estimations are mixed. When we control for the ratio of reserves to short-term debt and for the deviation of the real exchange rate from trend, the effect of the terms of trade on crisis probability is far from clear-cut. Several exploratory specifications (not reported) suggest that a positive terms-of-trade shock—identified by either the change over previous periods or the deviation from a Hodrick-Prescott trend–increases the probability of a crisis. Another striking result is the lack of a statistically significant direct relation between changes in international interest rates (proxied here by the U.S. Treasury bill rate) and crisis probability.[9]

These odd results, if they stand closer scrutiny, could result from correlations with our main variables that relate to the crisis probability: the ratio of reserves to short-term debt and the deviations of the exchange rate from trend. A fall in the terms of trade or an increase in international interest rates could influence crisis probability through its impact on reserve policy. Evidence on this front is suggestive.[10]

The interaction term between international interest rates and the stock of total external debt (a common measure of the financial burden of external debt) is statistically related to crisis probability in only one specification.

Exchange rate regime

The stock of reserves is related to the exchange rate regime in a trivial way. A fixed exchange rate regime should lead to a close relation between the adjustment of the money market and movements in

9. Results are available in García and Soto (2004).

10. García (1999) finds that, in contrast to the predictions of standard models of reserve demand, the correlation between reserves and international interest rates is negative for emerging economies. Exploring regressions that include the ratio of reserves to short-term debt lead to a positive, but only slightly significant, effect of the international interest rate on crisis probability.

reserves, while a floating exchange rate regime should allow reserves to move more independently of monetary developments. A more difficult question is whether countries with a particular exchange rate regime would choose to hoard more or less reserves, on average. This is linked to is the sensitivity of a particular exchange rate regime to crises. To assess this latter issue, we include a measure of the exchange rate regime as an additional regressor in our crisis probability specifications. We use Reinhart and Rogoff's (2002) measure of exchange rate regimes, extrapolated for the period 2000 to 2002. To prevent the simultaneity problem that would arise from including the contemporaneous exchange rate regime and the occurrence of a crisis, we lag the regime variable by two years. The results obtained are included in tables 1 through 3. We find that the exchange rate regime is, in fact, related to crisis probability. The results are robust to a number of different specifications and measures of reserves, and they show that, compared to the baseline of a hard peg, fixed regimes are more prone to crisis. Flexible regimes, on the other hand, are not particularly less prone to crisis, as could be expected.

Hence, our results show that the worst choice, in terms of external vulnerability, is a weak commitment to a fixed exchange rate. This result is consistent with the commonly held view that economies have tended to abandon intermediate regimes for either a full float or a hard peg (Fischer, 2003).

2.3 Different Measures of Crises

In related literature, an alternative variable often chosen to indicate the occurrence of a crisis is a large current account reversal. We estimated similar specifications as those presented above, replacing the exchange rate market pressure variable with the occurrence of a large swing in the current account (more than 4 percent). Baseline results are presented in tables 4 through 6. The scaled reserve variable remains statistically significant in all cases, while the real exchange rate misalignment is still strongly related to this crisis measure. The specifications that include the exchange rate regime variable still have the same implications for the fixed regimes as the previous results, but they are statistically significant in only a few cases. However, flexible exchange rate regimes now seem to reduce the likelihood of crises, though the coefficients are not statistically significant. One variable that appears to be strongly related to the current account reversal is a measure of the openness of the economy.

Table 4. Benchmark Estimation of Crisis Probability (measured by Current Account reversals), with Liquidity Measured as Reserves to Short-Term Debt: BIS Data[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
REER MIS	–3.013	–2.9	–2.841	–2.79	–2.625	–2.506	–2.41	–2.362
	(2.63)**	(2.52)*	(2.41)*	(2.36)*	(2.27)*	(2.15)*	(2.03)*	(1.98)*
OPEN	4.222	4.311	4.173	4.293	4.261	4.347	4.204	4.329
	(3.99)**	(4.08)**	(3.92)**	(4.06)**	(3.97)**	(4.06)**	(3.90)**	(4.04)**
R/STD	–0.458	–0.432	–0.456	–0.434	–0.463	–0.439	–0.459	–0.44
	(2.66)**	(2.58)**	(2.65)**	(2.59)**	(2.62)**	(2.55)*	(2.60)**	(2.56)*
TD/GDP	0.539		0.601		0.474		0.549	
	(1.24)		(1.34)		(1.08)		(1.21)	
CRED	–3.091	–2.999	–3.223	–3.093	–2.662	–2.589	–2.806	–2.696
	(3.85)**	(3.74)**	(3.82)**	(3.67)**	(3.19)**	(3.11)**	(3.24)**	(3.12)**
PUB. DEBT		0.664		0.704		0.572		0.618
		(1.32)		(1.37)		(1.12)		(1.19)
Growth			1.186	0.87			1.493	1.139
			(0.58)	(0.43)			(0.72)	(0.55)
Exports					–2.064	–1.937	–2.171	–2.018
					(1.58)	(1.50)	(1.64)	(1.55)
FIX	0.774	0.668	0.764	0.656	0.799	0.667	0.786	0.65
	(1.18)	(1.01)	(1.16)	(1.00)	(1.21)	(1.00)	(1.19)	(0.98)
MANAGED	0.237	0.105	0.237	0.096	0.183	0.049	0.181	0.037
	(0.52)	(0.23)	(0.52)	(0.21)	(0.40)	(0.11)	(0.39)	(0.08)
FLOAT	–0.512	–0.603	–0.502	–0.599	–0.623	–0.719	–0.616	–0.718
	(0.99)	(1.17)	(0.97)	(1.16)	(1.17)	(1.35)	(1.15)	(1.35)
Constant	–3.315	–3.184	–3.384	–3.22	–3.148	–3.01	–3.229	–3.052
	(5.65)**	(5.81)**	(5.57)**	(5.74)**	(5.30)**	(5.41)**	(5.26)**	(5.38)**
Summary statistic								
Pseudo R^2	0.13	0.13	0.13	0.13	0.14	0.13	0.14	0.13
No. observations	567	528	565	526	561	522	559	520
No. crisis	51	51	51	51	50	50	50	50

Source: Authors' calculations, based on data from the Bank for International Settlements (BIS).
* Statistically significant at 10 percent.
** Statistically significant at 1 percent.
a. Absolute value of z statistics are in parentheses. See appendix for definition of explanatory variables.

Table 5. Benchmark Estimation of Crisis Probability (measured by Current Account reversals), with Liquidity Measured as Reserves to Short-Term Debt: World Bank Data[a]

Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
REER MIS	–0.214	–0.194	–0.254	–0.248	–0.107	–0.091	–0.117	–0.11
	(0.36)	(0.33)	(0.43)	(0.42)	(0.18)	(0.16)	(0.20)	(0.19)
OPEN	2.76	2.835	2.736	2.799	2.971	3.042	2.971	3.038
	(3.79)**	(3.92)**	(3.75)**	(3.86)**	(3.98)**	(4.10)**	(3.95)**	(4.07)**
R/STD	–0.153	–0.165	–0.152	–0.163	–0.141	–0.152	–0.142	–0.153
	(2.16)*	(2.35)*	(2.15)*	(2.32)*	(1.99)*	(2.16)*	(1.98)*	(2.14)*
TD/GDP	0.619		0.581		0.562		0.576	
	(2.03)*		(1.84)*		(1.82)*		(1.81)*	
CRED	–1.556	–1.569	–1.486	–1.478	–1.396	–1.41	–1.431	–1.425
	(3.10)**	(3.13)**	(2.81)**	(2.80)**	(2.72)**	(2.75)**	(2.65)**	(2.65)**
PUB. DEBT		0.691		0.656		0.631		0.644
		(1.93)*		(1.80)*		(1.74)*		(1.75)*
Growth			–0.491	–0.637			0.313	0.154
			(0.39)	(0.51)			(0.24)	(0.12)
Exports					–2.275	–2.267	–2.424	–2.398
					(3.14)**	(3.14)**	(3.23)**	(3.20)**
FIX	0.438	0.438	0.442	0.446	0.55	0.547	0.567	0.565
	(0.92)	(0.92)	(0.93)	(0.94)	(1.15)	(1.14)	(1.17)	(1.17)
MANAGED	0.201	0.168	0.211	0.18	0.21	0.179	0.237	0.203
	(0.75)	(0.64)	(0.78)	(0.67)	(0.78)	(0.67)	(0.86)	(0.75)
FLOAT	–0.239	–0.262	–0.244	–0.27	–0.276	–0.297	–0.258	–0.284
	(0.78)	(0.85)	(0.78)	(0.87)	(0.89)	(0.95)	(0.82)	(0.90)
Constant	–3.012	–2.918	–2.965	–2.875	–2.997	–2.913	–3.025	–2.932
	(8.48)**	(8.74)**	(7.99)**	(8.32)**	(8.32)**	(8.59)**	(8.01)**	(8.33)**
Summary statistic								
Pseudo R^2	0.07	0.07	0.07	0.07	0.09	0.09	0.09	0.09
No. observations	1000	1000	976	976	994	994	970	970
No. crisis	112	112	111	111	111	111	110	110

Source: Authors' calculations, based on data from the World Bank's *World Development Indicators*.
* Statistically significant at 10 percent.
** Statistically significant at 1 percent.
a. Absolute value of z statistics are in parentheses. See appendix for definition of explanatory variables.

Table 6. Benchmark Estimation of Crisis Probability (measured by Current Account reversals), with Liquidity Measured as Reserves to Total Debt: World Bank Data[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
REER MIS	–3.226	–0.062	–3.124	–0.111	–2.813	0.025	–2.674	0.008
	(2.96)**	(0.10)	(2.80)**	(0.19)	(2.53)*	(0.04)	(2.35)*	(0.01)
OPEN	5.62	4.049	5.633	4.001	5.544	4.197	5.551	4.244
	(4.81)**	(5.22)**	(4.81)**	(5.09)**	(4.70)**	(5.27)**	(4.71)**	(5.23)**
R/TD	–4.734	–3.018	–4.758	–3.017	–4.604	–2.877	–4.618	–2.963
	(3.71)**	(3.79)**	(3.73)**	(3.70)**	(3.56)**	(3.55)**	(3.58)**	(3.57)**
STD/TD	0.905		0.888		1.095		1.079	
(BIS)	(1.88)*		(1.84)*		(2.13)*		(2.10)*	
CRED	–3.299	–1.475	–3.407	–1.392	–2.961	–1.339	–3.078	–1.365
	(4.03)**	(2.91)**	(3.94)**	(2.61)**	(3.45)**	(2.59)**	(3.46)**	(2.51)*
STD/TD		2678		2747		2585		2621
(WB)		(2.61)**		(2.67)**		(2.49)*		(2.52)*
Growth			0.925	–0.553			1.18	0.26
			(0.44)	(0.44)			(0.55)	(0.20)
Exports					–1.9	–2.223	–1.999	–2.368
					(1.47)	(3.08)**	(1.53)	(3.16)**
FIX	1.224	0.457	1.202	0.47	1.229	0.595	1.204	0.62
	(1.79)*	(0.95)	(1.76)*	(0.97)	(1.79)*	(1.21)	(1.75)*	(1.26)
MANAGED	0.583	0.232	0.567	0.249	0.528	0.239	0.511	0.268
	(1.24)	(0.87)	(1.20)	(0.92)	(1.11)	(0.89)	(1.07)	(0.98)
FLOAT	–0.252	–0.143	–0.256	–0.149	–0.372	–0.183	–0.378	–0.163
	(0.47)	(0.46)	(0.48)	(0.47)	(0.67)	(0.58)	(0.68)	(0.51)
Constant	–3.574	–3.184	–3.59	–3.168	–3.477	–3.179	–3.496	–3.205
	(6.55)**	(9.03)**	(6.50)**	(8.84)**	(6.34)**	(8.90)**	(6.30)**	(8.76)**
Summary statistic								
Pseudo R^2	0.14	0.08	0.14	0.08	0.15	0.1	0.15	0.1
No. observations	567	1000	565	976	561	994	559	970
No. crisis	51	112	51	111	50	111	50	110

Source: Authors' calculations, based on data from the World Bank's *World Development Indicators*.
* Statistically significant at 10 percent.
** Statistically significant at 1 percent.
a. Absolute value of z statistics are in parentheses. See appendix for definition of explanatory variables.

2.4 Financial Development, Political Variables, and Crisis Probability

One of the hypotheses we explore in this paper is that the probability of a crisis may be affected by institutional aspects. In particular we are interested in evaluating the impact of financial market development on crises and the role of political institutions in determining a country's vulnerability to external shocks. We expect that more developed financial systems should allow lessen the need for reserves to stave off crises. A deeper or better-functioning financial system should facilitate the funneling of domestic resources to prevent costly adjustments in the face of crises. At the same time, we expect that solid political institutions, in the sense that they are transparent and accountable, reduce the likelihood of crony capitalism, allow market participants to see economic policy measures as credible, and are themselves better suited to face financial turbulence promptly and efficiently.[11]

The empirical problem with this hypothesis is that it is inherently difficult to select a particular variable that summarizes the implication of political institutions for a country's vulnerability. We draw from other work and use an index of institutional development, constructed as the first principal component of four indicators: the prevalence of law and order, the quality of bureaucracy, the absence of corruption, and the accountability of public officials.[12] We call this the governance index, and we also use some of the indicators individually.

To analyze the implications of financial development on crisis probability, we use the database on financial system indicators presented by Demirgüç-Kunt and Levine (2001), from which we select four indicators. Two are intended to reflect the efficiency of the financial sector, and two capture the size of the financial market. With respect to efficiency, we expect that an efficient financial system reduces the probability of a crisis by increasing the informational content of price signals and thus allowing the private sector to adjust smoothly. The variables we selected to measure efficiency are the net interest margin and the stock market turnover. The net interest margin is measured as the accounting value of a bank's net interest

11. Aizenman and Marion (2004) show that the quality of political institutions may affect the optimal level of reserve holdings.

12. We thank César Calderón for providing us with this dataset. The original source is Political and Risk Services (PRS) Group, *International Country Risk Guide* (various issues).

revenues as a share of total assets. A lower reliance on this type of income reflects narrower spreads between lending and borrowing rates, and it is therefore indicative of a more competitive banking system. A low net interest margin also implies that the financial market is characterized by few informational asymmetries or by heterogeneous agents whose idiosyncratic risk is muted. Meanwhile, high stock market turnover is indicative of low transaction costs or a large degree of liquidity in stocks.

With regard to the size of the financial market, a large financial sector should allow the fiscal or monetary authorities to tap the required resources to stave off liquidity shocks, instead of having to draw on international reserves. We selected two variables to capture size: stock market capitalization and total private credit by banks and similar institutions.

Tables 7 and 8 summarize the effects of including the financial system variables and the governance index, both individually and with an interaction term, in the three benchmark estimates (one for each scaling variable for reserves). Both financial and political variables are lagged two years to mitigate simultaneity bias. Panel A in both tables reports the median of the coefficient of the benchmark variables and the number of times the respective variable is statistically significant out of the total number of specifications (in brackets). Panel B reports the coefficient of each of the institutional variables included in different specifications (these variables do not enter simultaneously, except for the interaction term).

The main results highlighted in the previous section still hold. Economic growth, real exchange rate misalignment, and the ratio of reserves to the different scaling variables are all statistically related to the crisis probability. The effect of the financial and political system variables is much less clear-cut. When included individually, governance variables (both the aggregate measure and the separate indicators of the prevalence of law and order and the absence of corruption) are far from statistically significant. The one exception is corruption, which seems to increase the crisis probability (see table 7).[13]

Financial system variables are also far from having a statistically significant effect on crisis probability when included alone. The exception here is the net interest margin, which has a negative effect on crisis probability. Interaction terms only slightly improve the results. The

13. A higher value for the index indicates a better quality of institution, so higher values for the corruption index indicate lower corruption.

Table 7. Crisis Probability and Institutional Development: Financial Variables

	Short-term debt (BIS)			Short-term debt (World Bank)			Total debt (World Bank)		
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
A. Benchmark variables (median coefficient)[a]									
REER MIS	–12.759	–13.421	–12.825	–5.539	–6.028	–5.5205	–6.1115	–6.5615	–6.251
	[4/4]	[4/4]	[4/4]	[4/4]	[4/4]	[4/4]	[4/4]	[4/4]	[4/4]
RES	–1.826	–1.887	–1.2955	–1.1785	–1.3635	–0.4215	–4.8805	–6.9565	–7.397
	[4/4]	[4/4]	[2/4]	[4/4]	[3/4]	[1/4]	[3/4]	[4/4]	[3/4]
Growth	–5.511	–9.073	–4.6	–1.6665	–1.94	–2.8	–2.136	–1.5755	–2.437
	[0/4]	[0/4]	[0/4]	[1/4]	[0/4]	[1/4]	[0/4]	[0/4]	[0/4]
Governance	.	0.1935	.	.	0.0985	.	.	0.0685	.
	.	[0/4]	.	.	[0/4]	.	.	[0/4]	.
B. Institutional variables[b]									
Capitalization	0.421	1.429	0.411	0.916	3.067	0.353	1.333	3.406	0.338
	(0.54)	(0.84)	(0.28)	(1.85)*	(2.58)**	(0.53)	(2.51)*	(2.88)**	(0.43)
Turnover	0.035	–1.212	4.397	–0.244	–1.116	2.635	0.1	–0.71	0.063
	(0.04)	(0.72)	(1.94)*	(0.31)	(0.96)	(1.49)	(0.13)	(0.63)	(0.05)
Credit	1.012	–0.823	0.685	1.472	1.751	1.541	2.114	2.276	0.423
	(0.99)	(0.44)	(0.50)	(2.23)*	(1.96)*	(1.76)*	(3.05)**	(2.46)*	(0.38)
Net. int. Margin	–25.345	–130.06	9.795	–13.039	–76.03	65.147	–10.935	–85.625	47.469
	(1.46)	(2.25)*	(0.26)	(0.68)	(1.76)*	(1.78)*	(0.62)	(2.07)*	(1.56)

Table 7. (continued)

	Short-term debt (BIS)			Short-term debt (World Bank)			Total debt (World Bank)		
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
C. Interaction of Financial variables with Insitutional variables and reserves[b]									
Gov*Capitalization	.	–1.573	.	.	–2.035	.	.	–1.897	.
	.	(0.84)	.	.	(2.12)*	.	.	(2.16)*	.
Gov*Turnover	.	1.017	.	.	0.987	.	.	1.397	.
	.	(0.92)	.	.	(1.16)	.	.	(1.69)*	.
Gov*Credit	.	1.013	.	.	–0.264	.	.	–0.225	.
	.	(0.78)	.	.	(0.44)	.	.	(0.37)	.
Gov*Net. Int. Margin	.	109.85	.	.	86.292	.	.	88.872	.
	.	(2.10)*	.	.	(2.00)*	.	.	(2.07)*	.
RES*Capitalization	.	.	0.005	.	.	0.571	.	.	4.354
	.	.	(0.01)	.	.	(1.57)	.	.	(2.39)*
RES*Turnover	.	.	–6.254	.	.	–3.665	.	.	0.182
	.	.	(1.84)*	.	.	(1.61)	.	.	(0.04)
RES*Credit	.	.	0.541	.	.	–0.088	.	.	9.425
	.	.	(0.37)	.	.	(0.12)	.	.	(2.09)*
RES*Net. int. Margin	.	.	–40.536	.	.	–86.703	.	.	–369.69
	.	.	(1.01)	.	.	(2.32)*	.	.	(2.02)*

Sources: Authors' calculations, based on data from the Bank for International Settlements (BIS) and the World Bank's *World Development Indicators*.
* Statistically significant at 10 percent.
** Statistically significant at 1 percent.
a. The figures in brackets are the number of times the coefficient is statistically significant at 10 percent.
b. Absolute value of z statistics are in parenthesis.

Table 8. Crisis Probability and Institutional Development: Political Variables

	Short-term debt (BIS)		*Short-term debt (World Bank)*		*Total debt (World Bank)*	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
A. Benchmark variables (median coefficient)[a]						
REER MIS	–8.175	–8.164	–6.172	–6.285	–6.635	–6.615
	[3/3]	[3/3]	[3/3]	[3/3]	[3/3]	[3/3]
RES	–0.437	–0.413	–0.21	0.115	–1.767	–2.334
	[3/3]	[1/3]	[0/3]	[1/3]	[1/3]	[1/3]
Growth	–10.903	–10.905	–8.44	–8.694	–9.268	–8.899
	[3/3]	[3/3]	[3/3]	[3/3]	[3/3]	[3/3]
B. Institutional variables[b]						
Governance	0.434	0.558	0.123	0.32	0.155	0.114
	(1.48)	(1.41)	(0.80)	(1.60)	(0.99)	(0.51)
L&O	0.225	0.233	0.058	0.195	0.08	–0.113
	(1.06)	(0.66)	(0.33)	(0.84)	(0.45)	(0.56)
Corruption	0.087	0.512	0.032	0.292	0.048	0.236
	(0.32)	(1.47)	(0.16)	(1.16)	(0.23)	(0.81)
RES*Governance	.	–0.109	.	–0.164	.	0.281
	.	(0.45)	.	(1.54)	.	(0.26)
RES*L&O	.	–0.006	.	–0.099	.	1.417
	.	(0.03)	.	(0.94)	.	(1.39)
RES*Corruption	.	–0.395	.	–0.186	.	–1.14
	.	(1.80)*	.	(1.90)*	.	(0.94)

Sources: Authors' calculations, based on data from the Bank for International Settlements (BIS) and the World Bank's *World Development Indicators*.
* Statistically significant at 10 percent.
** Statistically significant at 1 percent.
a. The figures in brackets are the number of times the coefficient is statistically significant at 10 percent.
b. Absolute value of z statistics are in parenthesis.

specifications in columns 2, 5, and 8 of table 7 better fit our hypothesis. These results indicate that good public institutions, measured by the governance variable, reduce the probability of a crisis, but this effect is biggest for economies with small financial systems, as measured by the amount of private credit or financial capitalization. These last two variables alone seem to increase the probability of crisis. Finally, our results show that a large net interest margin increases the probability of a crisis, but only for high values of the governance variable, which by itself is negatively, although not significantly, related to this probability.

The previous specifications attempt to detect whether institutional variables per se affect crisis probability. An alternative is that institutional variables are substitutes for reserves in determining the likelihood of a crisis. If this was the case, the marginal contribution of the stock of reserves to the crisis probability should depend on the degree of institutional development. The bottom rows of tables 7 and 8 present specifications in which the reserves variable is interacted with the institutional measures. The results are again inconclusive, and only in a few cases are they statistically significant. These results, and those reported above, are not clear enough to make a strong case that institutional variables reduce the likelihood of a crisis once one controls for reserve accumulation and real exchange rate misalignment. Of course, good institutions could limit the probability of a crisis indirectly through the choice of exchange rate regime, as well as reserves and exchange rate policies.

Political and financial variables thus do not appear to be strongly related to crisis probabilities in our specifications. The effects are not always statistically significant, and the signs are often opposite to what we expected. In contrast, the results of the benchmark estimates hold. The ratio of short-term debt to several measures of liabilities, the growth rate, and exchange rate misalignment are all still strong determinants of crisis probability.

3. An Assessment of Recent Trends in Reserve Accumulation

In the debate on reserve accumulation by East Asian economies, some analysts argue that while reserves may be a useful tool for avoiding a crisis, the level of reserves needed to actually prevent a financial crisis is limited. Specifically, a ratio of reserves to short-term external debt above one would considerably reduce the crisis vulnerability of a country, but a ratio much above one would do nothing to reduce the risk of a crisis (see, for example, IMF, 2003). While theoretical arguments can be made to justify such an assertion, no one has undertaken a systematic quantitative evaluation of the contribution of reserves to reduce the crisis vulnerability.

In this section, we take our earlier estimates of crisis probability at face value to evaluate recent trends in reserve accumulation by some emerging East Asian economies and Chile. Importantly, our model for crisis probability encompasses nonlinear effects of liquidity measures. While these nonlinear effects may not be enough to capture a possible threshold level for the ratio of reserves to short-term debt above which its marginal contribution to reducing the risk of a crisis is nil, at least the quantitative magnitude arises from empirical estimates.

We perform two types of exercises. First, we determine the optimal level of reserves for each country under different assumptions about the cost of a crisis. Second, we establish the implicit cost of a crisis that underlies actual holdings of reserves, under the assumption that the reserve level is optimally determined in each country through a cost-benefit analysis.[14]

To determine the optimal level of reserves, we closely follow the cost-benefit analysis of Ben Bassat and Gottlieb (1992). Consider the problem of a central bank that decides the amount of reserves it will carry over period t by minimizing an expected loss function that considers both the effects of reserve accumulation in terms of reducing the expected cost of a crisis and the opportunity cost of reserves.[15] We assume the loss function for the authority takes the following form:

$$\Lambda_t = p_t C_t + \left(1 - p_t\right) \rho_t R_t \,, \tag{6}$$

where p_t is the probability of a crisis, which depends on the ratio of reserves to short-term debt and which is given by expression 5 above; C_t is the cost of a crisis; R_t is the level of reserves; and ρ_t is the unit cost

14. The optimal or adequate level of reserves for a country is usually determined either by estimating a reserve demand model (Aizenman and Marion, 2003; Flood and Marion, 2001) or by using simple adequacy indicators (Wijnholds and Kaptyen, 2001). Lee (2004) develops an alternative options-based approach to establish the optimal amount of reserves.

15. De Gregorio and Lee (2003) and Park and Lee (2002), among others, show that real output growth typically follows a *V* pattern over the period before and after a crisis. However, the post-crisis growth rate for those countries does not exceed the precrisis period average, which means that a crisis entails a permanent output loss.

of reserves. The authority decides the optimal amount of reserves each period by minimizing equation 6 subject to

$$K_t - W_t + R_t = D_t \, , \tag{7}$$

where K_t is the capital stock of the economy, W_t is total wealth, and $D_t = S_t + \mathrm{LTD}_t$ is the total debt of the country (composed of short-term debt, S_t, and medium- and long-term debt, LTD_t). We assume that short-term debt is predetermined, and any change in reserves is financed with medium- and long-term borrowing. This assumption allows us to reach an interior solution for the optimal amount of reserves. If reserves are completely financed with short-term debt, then any change in reserves conveys a one-to-one change in short-term debt, and the ratio between these two variables is never modified. This implies that the authority cannot affect the probability of a crisis by adjusting reserves. Since carrying reserves is costly and provides no benefit, then the optimal amount would tend to be zero.

We assume that reserves affect not only the probability of a crisis, but also the cost of a crisis. Depending on how reserves are used and whether the crisis originates in a liquidity shock, large amounts of international reserves could imply that countries avoid costly liquidation of assets. This, in turn, would reduce the impact of the shock on domestic output. De Gregorio and Lee (2003), for example, find a statistically significant effect of liquidity—measured as reserves relative to either domestic liabilities (M2) or short-term debt—on reducing the cost of a balance-of-payments crisis.[16]

In our case, we assume that the cost of a crisis (as a share of GDP) is a function, among other variables, of the ratio of reserves to short-term debt:

$$\frac{C_t}{Y_t} = C\left(\frac{R_t}{Y_t}, \ldots \right).$$

The first-order condition for the authority's problem is given by the following expression:

$$p_{R,t} C_t + p_t \frac{\partial C_t}{\partial R_t} + (1 - p_t)\rho_t - p_{R,t}\rho_t R_t = 0 \, , \tag{8}$$

16. De Gregorio and Lee (2003) also find that financial soundness, real exchange rate depreciation, and monetary policy play a critical role in reducing output losses associated with balance-of-payments crises.

where the partial derivative of the crisis probability with respect to R_t is given by

$$p_{R,t} = p_t(1 - p_t)\left(\beta_0 \frac{1}{S_t} + \beta_0 \frac{1}{Y_t}\right).$$

We have assumed that the opportunity cost of reserves is independent from the ratio of reserves to short-term debt. In theory, this opportunity cost corresponds to the difference between the marginal productivity of capital in the economy and the yield on reserves, which is typically lower than then productivity of capital. In our empirical application below, we use the sovereign spread of each country in our sample as a proxy for this opportunity cost. These sovereign spreads depend on the perceived risk of each country, and they could therefore be affected by the country's international liquidity. However, empirical estimations of the determinants of sovereign spreads for emerging economies show that the effect of reserves is negligible and in many cases statistically insignificant. Some recent empirical studies for emerging markets further show that short-run movements in spreads are explained by changes in market conditions rather than fundamentals (Naudon, 2004). Since we do not consider possible effects of reserves on spreads, our results should tend to underestimate the optimal level of reserves.

On combining the previous two expressions, we obtain the following nonlinear equation in R_t:

$$0 = (1 - p_t)p_t\left[\beta_0\left(\frac{S_t}{Y_t}\right)^{-1} + \beta_1\right]\left(\frac{C_t}{Y_t} - \rho_t \frac{R_t}{Y_t}\right) + p_t\eta\left(\frac{S_t}{Y_t}\right)^{-1}(1 - p_t)\rho_t, \qquad (9)$$

where

$$\eta = \frac{\partial C_t}{\partial(R_t / S_t)}$$

corresponds to the change in the cost of a crisis associated with a change in the ratio of reserves to short-term debt.

3.1 Optimal Level of Reserves for Selected Economies

We compute the optimal level of reserves derived from equation 9 for four Asian economies (China, Korea, Malaysia, and Thailand) and Chile. As a proxy for the opportunity cost, we use data on sovereign spreads from the J.P. Morgan Emerging Markets Bond Index Global (EMBI Global). We use two of our benchmark estimates of crisis probability from the previous section: one based on BIS data to construct the ratio of reserves to short-term debt (specification 7 in table 1) and one that draws on World Bank data (specification 7 in table 2). Finally, we assume that $\eta = -0.0025$, which is the value estimated by De Gregorio and Lee (2003) for the marginal effect of the ratio of reserves to short-term debt on the cost of a crisis.

Table 9 presents the estimates of the optimal level of reserves for three possible crisis costs: 5 percent GDP, 10 percent GDP, and 15 percent GDP. These figures correspond roughly to the costs of a currency crisis, a currency crash, and a banking crisis, respectively, according to estimates by the International Monetary Fund (IMF, 1998).[17]

The results based on the BIS data indicate that the amount of reserves held by Korea, Malaysia, and Thailand in 2003 is not above what would be optimal for those countries.[18] The amount of reserves that these countries are countries would be justified even if the cost of a crisis is low. In fact, for a mild crisis cost, the optimal amount of reserves could be up to 100 percent higher than what is actually being held. If we consider the results based on the World Bank data, however, the amount of reserves held by Korea and Thailand is roughly consistent with the optimal amount for a mild crisis, whereas Malaysia is holding a clear excess of reserves.

In the case of China, actual reserves are at least twice the optimal level according to the BIS estimates, no matter how strong the crisis. Based on these estimates, the optimal level of reserves in 2003 was approximately 12.3 percent of GDP if we consider a crisis cost of 15 percent of GDP. This number is 85 percent less than the amount of reserves that China is currently holding. When we consider the World Bank estimates, China's reserves are consistent with a cost of a crisis that ranges from mild to strong.

In the case of Chile, actual reserves are systematically above the optimal level. The only exceptions are when the comparison is the optimal

17. According to figures reported by the IMF (1998), the average cost of a currency crisis, a currency crash, and a banking crisis in emerging markets—in terms of loss of output relative to trend—is approximately 7.6 percent of GDP, 10.7 percent of GDP, and 14.0 percent of GDP, respectively.

18. The optimal level of reserves for these three countries is not well defined for the years 2000 and 2001 because the crisis probability in those years is polluted by the recovery period after the Asian crisis.

Table 9. Actual and Optimal Reserves

		Optimal reserves					
		Crisis cost = 5% GDP		*Crisis cost = 10% GDP*		*Crisis cost = 15% GDP*	
Country and year	*Actual reserves (% GDP)*	*BIS*	*World Bank*	*BIS*	*World Bank*	*BIS*	*World Bank*
Chile							
2000	20.0	7.77	9.10	10.16	13.39	11.58	16.05
2001	19.9	0.00	1.81	13.84	11.72	27.57	17.93
2002	21.6	0.12	0.66	19.20	10.66	30.94	16.93
2003	23.9	0.00	0.00	16.18	11.34	31.62	19.66
China							
2000	15.9	4.45	6.63	6.58	10.48	7.87	12.86
2001	15.6	5.89	6.31	8.98	9.21	10.83	11.01
2002	18.3	6.88	8.74	9.67	17.52	11.35	22.96
2003	23.0	7.51	12.15	10.48	21.54	12.28	27.36
Korea							
2000	18.2	...	...	...	...	...	...
2001	20.8	...	...	...	...	...	...
2002	24.1	21.80	0.33	34.85	18.87	42.65	30.52
2003	25.5	37.06	17.14	52.08	38.53	60.98	51.86
Malaysia							
2000	38.6	...	...	...	...	...	...
2001	32.7	...	...	...	...	...	...
2002	34.6	41.49	0.00	57.43	11.64	66.75	20.12
2003	36.1	51.12	2.01	69.17	17.38	79.70	27.04
Thailand							
2000	27.8	...	...	...	...	...	...
2001	26.1	...	...	...	...	...	...
2002	28.0	38.37	0.00	53.27	19.31	62.10	35.77
2003	30.0	30.31	1.40	43.34	24.82	51.11	39.50

Sources: Authors' calculations, based on data from the Bank for International Settlements (BIS) and the World Bank's *World Development Indicators*.
... Does not apply (see footnote 18).

level for the past three years based on BIS data and when the cost of a crisis is 15 percent of GDP. For a moderate cost (10 percent of GDP), reserves are between 40 and 100 percent above the optimal level.

3.2 Implicit Cost of a Crisis

An alternative method for evaluating reserves consists in determining the implicit cost of a crisis that is behind the actual reserve level being held. Table 10 presents these estimates, under the assumption that the reserve level is determined optimally according to equation 9.

The implicit cost of a crisis ranges from 2.9 to 6.6 percent GDP in the case of Korea to 4.9 to 11.6 percent of GDP for Thailand. In other words, the reserve levels of these two countries is consistent with a soft to mild crisis. In the case of Malaysia, the implicit cost of a crisis could be very low if we use the estimates based on BIS data (2.8 percent) or relatively high if we consider the World Bank data (21.7 percent). Our conclusion with respect to the adequacy of reserves for this country is thus mixed.

The cost of a crisis that is implicit in the level of reserves held by China is extremely high when we consider the estimate based on BIS data. According to our calculations, the cost of a crisis that would justify the amount of reserves held would be approximately 150 percent of GDP, which is clearly larger than any actual crisis. Under the estimates based on World Bank data, the implicit cost of a crisis is consistent with a mild crisis (approximately 11 percent of GDP).

To understand why the reserve level held by countries such as Korea and Thailand do not seem to be above the optimum for those countries, it is necessary to consider both the cost of holding reserves and the probability of a crisis. For these two countries, the estimated probability of a crisis in the last two years was not extremely high (2.6–5.9 percent in the case of Korea and 2.5–5.0 percent in the case of Thailand), but it was much larger than the crisis probability of countries like China (roughly 0–1 percent percent). At the same time, the cost of carrying reserves for these two economies has been very low, at around 100 basis points over the last two years. Therefore, the cost-benefit analysis implicit in equation 9 suggests that the optimal level of reserves should be relatively high.

The clear excess of reserves in the case of China with the BIS data stems from the fact that the crisis probability is very low. In fact, the cost of reserves for China is the lowest of all the countries in our sample (less than 100 basis points in the last two years). In other

Table 10. Implicit Cost of a Crisis and Crisis Probability

	Actual reserves	*Spread*	*Crisis probability (%)*		*Implicit cost (% GDP)*	
Country and year	*(% GDP)*	*(basis points)*	*BIS*	*World Bank*	*BIS*	*World Bank*
Chile						
2000	20.0	197	4.31	0.49	7.6	27.0
2001	19.9	192	3.53	1.66	12.0	17.0
2002	21.6	177	3.30	1.35	10.9	20.1
2003	23.9	126	2.53	1.39	12.3	18.4
China						
2000	15.9	136	0.13	0.34	48.8	24.9
2001	15.6	127	0.14	0.15	41.8	40.7
2002	18.3	89	0.05	1.07	77.7	10.6
2003	23.0	57	0.02	0.73	159.6	11.1
Korea						
2000	18.2	216	...	...	...	...
2001	20.8	211	...	...	...	...
2002	24.1	121	3.04	2.61	5.7	12.0
2003	25.5	106	5.87	4.61	2.9	6.6
Malaysia						
2000	38.6	217	...	...	...	...
2001	32.7	237	...	...	...	...
2002	34.6	187	8.84	1.33	3.7	29.3
2003	36.1	151	10.01	1.57	2.8	21.7
Thailand						
2000	27.8	163	...	...	...	...
2001	26.1	160	...	...	...	...
2002	28.0	103	5.05	2.87	3.0	12.4
2003	30.0	91	2.60	2.49	4.9	11.6

Sources: Authors' calculations, based on data from the Bank for International Settlements (BIS) and the World Bank's *World Development Indicators*.
... Does not apply (see footnote 18).

words, the excess reserves for this country does not result from the high cost of carrying reserves, but from the low benefits of holding them. The low spread in the case of China reflects, in part, the low risk of a crisis for this country.

Finally, the implicit cost of a crisis in the case of Chile corresponds to the cost of a mild to severe crisis. However, this implicit cost is much lower that the cost of the Chilean crisis in the early 1980s which was in the range of approximately 20 to 40 percent of GDP.

4. Conclusions

A number of studies argue that reserve accumulation allows countries to reduce the likelihood of self-fulfilling speculative attacks. Analysts also stress that reserve accumulation is a relatively costly self-insurance strategy that can actually be counterproductive. Large stocks of reserves may create moral hazard problems that could weaken a country's financial system. This, in turn, could make crises deeper in those economies.

In this paper, we estimated the impact of reserves on the probability of a crisis. Our goal was to evaluate how robust reserves (or the lack of thereof) are in explaining a crisis after we control for set of indicators, including the quality of political institutions and the soundness of the financial system. The empirical evidence we presented indicates that the probability of crisis is still strongly related to the ratio of reserves to short-term debt even when we control for institutional variables.

We then used our estimates of crisis probabilities to evaluate the optimal level of reserves from a cost-benefit analysis for a selected group of East Asian economies and for Chile. This exercise demonstrated that the actual size of the reserve stock observed today in some of these countries is not out of line with the usual cost of a crisis. Our results lead us to the conclusion that recent trends in reserve accumulation by Asian economies could be a sensible approach to dealing with the current macroeconomic conditions in the world economy.

APPENDIX
Variable Definitions

Variable	*Definition*[a]
REER MIS	Lag of real effective exchange rate deviation from Hodrick-Prescott tendency (IFS)
R/STD	Lag of real reserves to real short-term debt (IFS/BIS, IFS/World Bank)
R/TD	Lag of real reserves to real total debt (IFS/WB)
STD/TD	Lag of short-term debt to total debt
Pub debt	Public debt (WB)
Growth	Real GDP growth average of lags 1 and 2 (World Bank)
Exports	Lag of real exports growth (IFS)
Corrupt	Second lag of corruption annual average ICRG(106)
L&O	Second of law and order annual average ICRG(113)
Governance	Second lag of governance (ICRG)
Capitalization	Second lag of stock market capitalization to GDP (DL2001)
Turnover	Second lag of stock market turnover to GDP (DL2001)
Credit	Second lag of private credit by deposit money banks and other financial institutions to GDP (DL2001)
Net int. margin	Second lag of net interest margin (DL2001)
Gov*Credit	Second lag of interaction between governance and private credit (ICRG, DL2001)
Gov*Capitalization	Second lag of interaction between governance and stock market cap (ICRG, DL2001)
Gov*Turnover	Second lag of interaction between governance and stock market turn (ICRG, DL2001)
Gov*Net. int. margin	Second lag of interaction between governance and net interest margin (ICRG, DL2001)
RES*Capitalization	Second lag of interaction between reserves and private credit (IFS, DL2001)
RES*Turnover	Second lag of interaction between reserves and stock market cap (IFS, DL2001)
RES*Credit	Second lag of interaction between reserves and stock market turn (IFS, DL2001)
RES*Net. int. margin	Second lag of interaction between reserves and net interest margin (IFS, DL2001)
RES*Governance	Second lag of interaction between reserves and governance (IFS, ICRG)
RES*L&O	Second lag of interaction between reserves and law and order (IFS, ICRG)
RES*Corruption	Second lag of interaction between reserves and corruption (IFS, ICRG)

a. Sources in parentheses.
DL2001: Demirgüç-Kunt and Levine (2001).
ICRG: *International Country Risk Guide.*
IFS: *International Financial Statistics.*

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Currency Mismatches in Chilean Nonfinancial Corporations

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The potential financial vulnerability that can occur when private sector or government agents acquire high levels of foreign currency debt has been at the center of discussion since the financial crises that affected the countries of Southeast Asia in the late 1990s. To the extent that a mismatch is generated in the denomination of assets and liabilities, foreign currency debt increases agents' vulnerability to fluctuations in the exchange rate. After a depreciation, the debt-asset ratios increase, interest rates rise in relation to income and access to new debt is limited. For firms in the private sector (especially those that operate in the nontradable sector), these balance sheet effects reduce output and investment and, in extreme cases, lead to the bankruptcy of firms and financial instability.

Measuring the empirical relevance of these negative effects of foreign currency debt is particularly important for the conduct of monetary and exchange rate policies in emerging markets. In conventional open-economy models à la Mundell-Fleming, exchange

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rate depreciations have an expansionary effect on domestic output. It follows that in the face of a contraction of foreign demand or a reduction of international liquidity, monetary authorities should reduce domestic interest rates and let the exchange rate depreciate in order to stabilize output. The expansionary effect of the depreciation of the peso may be reversed, however, if firms are highly indebted in dollars and the balance sheet effects are significant. Under these circumstances, the optimal policy response to a negative external shock would be a tight monetary policy and a strong defense of the peso.[1]

A growing literature, using aggregate data, finds empirical evidence that justifies this concern about the effects of the mismatches generated by the dollar debt. In particular, evidence shows that both dollarization of external liabilities and dollarization of the domestic financial system are correlated with increased volatility of output and capital flows and with greater financial vulnerability. Moreover, external dollarization reduces the expansionary effects of a depreciation and makes a sudden stop in capital flows more likely.[2]

In contrast to the macroeconomic literature, a second group of studies based on firm-level data obtains ambiguous results on the impact of a depreciation on investment and output of firms with dollar debt.[3]

1. Although they suffer problems of endogeneity, a couple of studies argue that the dollarization of liabilities leads to a "fear of floating" the domestic currency. Panizza, Hausmann, and Stein (2001) find that countries that are able to borrow externally in their own currencies allow greater fluctuations of the exchange rate relative to fluctuations of the interest rate and their reserves. Along a similar line of research, Levy Yeyati, Sturzenegger, and Reggio (2003), using de facto and de jure classifications of the exchange rate, find that the level of dollar liabilities (relative to the money supply) is positively correlated with the probability of fixing the exchange rate.

2. McKinnon and Pill (1998) document that many of the Asian economies that experienced financial crises in the second half of the 1990s maintained high levels of dollar debt. Calvo, Izquierdo, and Mejía (2004) find that domestic bank dollarization, measured by the sum of dollar deposits and foreign loans, increases the likelihood of a sudden stop in net capital inflows. Levy Yeyati (2003, 2005) shows that a banking crisis is more likely after a currency depreciation in countries in which domestic banks are highly dollarized, and these countries also have more volatile output growth rates. Céspedes (2004) provides evidence that exchange rate depreciations have a less expansionary effect when the level of dollar debt is higher. Eichengreen, Hausmann, and Panizza (2003) show that countries with a higher proportion of dollar-denominated foreign debt have more volatile growth of output and capital flows, and their sovereign debt obtains lower ratings from the rating agencies. Finally Arteta (2003) presents evidence in the opposite direction. This author does not find statistically significant evidence that dollarization in the domestic banking system makes a banking crisis more likely.

3. For a detailed summary of the literature on balance sheet effects from dollar debt, see Galindo, Panizza, and Schiantarelli (2003) and Bleakley and Cowan (2005).

This ambiguity has two possible explanations. The first is that currency mismatches are not quantitatively important, and the macroeconomic evidence is therefore likely to be capturing omitted variables, correlated with the level of dollarization, which are the true determinants of the financial volatility and vulnerability. The second explanation relates to the endogeneity of the currency composition of the debt. This explanation has two components. The first relates to the use that this literature makes of the dollar debt as a proxy for currency mismatches. If the firms that maintain dollar debt are also the firms whose income is highly correlated with the real exchange rate, then dollar debt will be a bad measure of the currency mismatch. The second component relates to the endogeneity of currency mismatch decisions. In particular, if firms with strong mismatches are precisely those for which the balance sheet effects are less important, depreciations could be expected to have a small effect on their output and investment levels.

In this study, we argue that the lack of conclusive empirical results at the firm level is due to the endogeneity of the debt choice, not to the absence of a balance sheet effect. To test this, we construct a new database of around 200 firms in the Chilean nonfinancial sector, which includes information on the currency composition of their liabilities, assets, and revenue and their net currency derivative positions. As far as we know, this is the first database that includes such detailed information on the currency mismatches on and off the balance sheet of firms in an emerging economy.

Our main result is that after we adequately control for differences in the composition of assets and revenue and for the net derivatives position, we find a significant balance sheet effect in the sample of Chilean firms. In other words, currency mismatch is important. We also find that currency derivatives play a role in isolating firms' investment decisions from currency shocks and that the balance sheet effect is smaller for firms that a priori we think have fewer constraints on access to credit.

On the choice of dollar debt, we find evidence of currency hedging among the Chilean firms. Firms in Chile hedge the currency composition of their liabilities, assets, and revenue, and they take derivative positions if they do not have a "real" hedge.[4] This is why dollar debt is higher in firms with dollar assets and in firms that export part of their sales. We

4. This result is consistent with the results obtained for Asia by Allayanis and Weston (2001).

also find that currency exposure is negatively correlated with measures of credit constraints and a measure of investment opportunities.[5] This suggests that the firms that are the most exposed to exchange rate risk are the best prepared for taking this risk.

A key question when considering the determinants of dollar debt is the role of exchange rate policy. By increasing the variance of the real exchange rate in the short and medium terms, a flexible exchange rate policy increases the relative risk of the dollar debt, inclining the balance in favor of the peso debt. In line with this hypothesis, we find significant changes in the level of currency exposure after the implementation of a floating exchange rate regime in Chile in 1999. This fall is significant, even after we control for interest rate differentials.

1. Effects and Determinants of Currency Mismatches: A Summary of the Literature

Several empirical studies use firm-level data to test the presence of a balance sheet effect generated by the increase in the peso value of dollar-denominated debt due to the depreciation of the exchange rate. At first sight, the results are not conclusive. Some studies find that, in the period immediately after a devaluation, dollar-indebted firms do not invest relatively less than firms with peso-denominated debt. Other articles conclude that the balance sheet effect is, in fact, important and statistically significant. The former group includes the work of Bleakley and Cowan (2005). In a sample of 450 nonfinancial firms from five Latin American countries, the authors do not find a negative and significant effect of dollar debt on investment following a depreciation. The authors argue that this result is due to the fact that firms hedge the composition of their liabilities with their assets and revenue, so a currency devaluation leads to an increase not only in the peso value of the debt, but also in the income received and the value of their assets. These results are confirmed by Bonomo, Martins, and Pinto (2003) using a sample of Brazilian firms; Benavente, Johnson, and Morandé (2003) using a sample of Chilean firms; and Echeverry and others (2003) using a large sample of Colombian firms (around 8,000). None of these studies finds a negative and significant coefficient for the interaction between dollar debt and exchange rate depreciation. Luengnaruemitchai (2004)

5. Measured as the deviations of dollar debt net of derivatives from the levels predicted by a simple regression between debt in dollars, assets in dollars, and exports.

studies the impact of depreciations on investment in nonfinancial firms in Asia, the region that brought the risks associated with currency mismatches to the forefront of the discussion following the financial crisis in the region in the late 1990s (see McKinnon and Pill, 1998). Again, it is not possible to identify a negative and significant effect of the interaction between dollar debt and the rate of currency depreciation.

There are several possible explanations for this lack of results. The first relates to the way in which currency exposure is measured. Although the firms with more dollar debt are affected by a contractionary balance sheet effect, this could be offset by a competitiveness effect derived from the fact that they have dollar-denominated assets or that their income is positively correlated with the currency depreciations. Consistent with this hypothesis, studies that control for the competitiveness effect find that the most dollar-indebted firms invest relatively less immediately after a depreciation—that is, after controlling for the competitiveness effect, there is a negative and significant balance sheet effect (Aguiar, 2002; Pratap, Lobato, and Somuano, 2003).

The second explanation relates to the endogeneity of currency exposure decisions. In particular, an extensive theoretical literature, as well as a growing empirical literature, maintains that firms determine their optimal level of risk exposure based on their vulnerability to situations of financial distress and their set of investment possibilities. Froot, Sharfstein, and Stein (1993) develop a model in which the cost of financial distress is the loss of investment opportunities. In this context, currency hedging reduces the cost of external financing and mitigates the problems of underinvestment described by Myers (1977). The implication is that firms will increase their currency hedging if they are vulnerable to critical financial situations or have better investment opportunities. In the context of the literature on balance sheet effects and currency exposure, this means that the investment decisions of firms with a high level of currency exposure could be less sensitive to balance sheet effects.

From the empirical point of view, firm-level studies that seek to explain firms' hedging decisions center mainly on the use of derivatives. Gezcy, Minton, and Schrand (1997), and Allayanis and Ofeck (2001), using data from 500 nonfinancial U.S. firms listed in Forbes, find that derivative use is positively correlated with investment opportunities, measured by expenditure on research and development, firm size, and the interaction between firm leverage and the market-to-book ratio (a measure of investment opportunities); and negatively correlated with the level of firm liquidity, measured by the quick ratio. Bartram, Brown, and Fhele (2004) use data on currency, interest rate, and commodity derivatives on 7,000 nonfinancial firms in forty-eight countries; they find that the firms that use currency derivatives the most also have income generated by foreign sales, are listed on foreign stock exchanges, or have foreign-currency-denominated debt. Firms also use currency hedging more if they have higher leverage, lower quick ratios, and higher market-to-book ratios.

Finally, Allayanis, Brown, and Klapper (2001) study currency hedging in nonfinancial firms from eight Asian economies over the 1996–98 period. In contrast to the U.S. studies, the evidence reported does not support the hedging theories described above. The authors find that liquidity-constrained firms and firms with higher investment opportunities do not use derivatives more and that currency derivatives are substitutes for foreign-currency revenue generated by sales. They also find that firms in countries with sufficiently large interest rate differentials have a lower level of hedging, which suggests that in this case firms trade off the higher risks of currency hedging with the benefits of cheap foreign credit.

2. Currency Mismatches, Balance Sheet Effects, and Hedging in Nonfinancial Firms

The empirical strategy in our framework is based on the estimation of a hedging equation at the firm level. The estimation is derived from a simple mean-variance framework in which we assume that the firm's profit function is concave on the level of its net worth:

$$\beta^{*} = \alpha + \frac{\tau + \varepsilon}{\mu \sigma_{z}}, \tag{1}$$

where β^* is the ratio of dollar debt to assets; α is the share of firm assets that produce foreign currency operational income; $\tau + \varepsilon$ is the expected interest rate differential between domestic and foreign currency debt, which we assume has an aggregate component τ, and a firm level idiosyncratic component ε; μ is a measure of firm risk aversion; and σ_z is the variance of the real exchange rate.

In the absence of interest rate differentials ($\tau + \varepsilon = 0$), the firm will choose the currency composition of its debt to match that of its assets (net operational income). However, if there are differential costs between peso and dollar borrowing, they will choose to carry some foreign exchange exposure in their balance sheet in order to reduce their expected borrowing costs. In other words, if there is a gap between domestic and foreign borrowing costs adjusted for expectations τ or if the firm has some idiosyncratic advantage that allows it cheaper access to foreign currency debt ε, then a currency mismatch will result. For a given interest rate differential, the size of this mismatch is decreasing in the expected volatility of the exchange rate, σ_z, and the degree of the firm's risk aversion, μ.

We start by measuring the size and significance of balance sheet effects on investment in Chilean firms in section 4. Our specific empirical strategy is to assess whether firms with more dollar debt invest relatively less in the aftermath of a depreciation. We do so by estimating reduced-form equations for fixed capital investment. The proposed mechanism centers on the interaction of alternative measures of currency mismatch with shifts in the exchange rate. Thus the key variable in our analysis in this section is for firm *i* in period *t*:

$$\text{FOREIGN DEBT}_{i,t-1} \times \Delta \ln \text{EXCHANGE RATE}_t \,.$$

If firms are behaving according to equation (1), foreign currency debt will be a poor measure of currency exposure in the balance sheet. If firms systematically match the currency composition of their assets and income α, with that of their liabilities β, then empirical estimates of the balance sheet effects based on dollar debt alone will be biased upwards, as firms holding high shares of dollarized debt see the largest increases in profits following a depreciation. We therefore augment this basic specification with a series of controls for α, using firm level data on exports, foreign assets, and net derivative positions.

In section 5, we examine the extent of matching between foreign currency assets, income, and liabilities directly within the cross-section of firms in our sample. First, we check the relation between foreign currency debt, net derivative usage, and the currency composition of assets and net income at the firm level. Next, we check whether variables that the corporate finance literature argues are correlated with firm risk aversion, μ, explain deviations in observed debt composition levels from the matching composition. Since we do not directly observe firm-level values of α, we look at the absolute value of deviations of β from the level predicted by the matching equations estimated in the previous subsection and correlate these deviations with proxies for μ.

Finally, in section 6, we analyze how the change in the macroeconomic policy regime in Chile in the late 1990s affected foreign currency hedging by firms. As is evident from equation (1), monetary and exchange rate policy affects the extent of hedging in firms through its impact on the economywide interest rate differential τ, and the exchange rate volatility σ_z. A key component of the new policy regime was the adoption of a floating exchange rate regime. This caused both an increase in exchange rate volatility and a compression of interest rate differentials. Therefore, we expect the level of currency exposure of Chilean firms to decline after the shift to the floating exchange rate regime in the late 1990s. We further test whether the decline was larger for firms that are likely to be more risk averse because of capital market imperfections. In the final section, we attempt to separate the effects of changes in interest differential from changes in exchange rate volatility after 1999.

3. The Database

Our data consist of firm-level accounting information for nonfinancial corporations in Chile for the period 1995 to 2003. We also have data on firm exports, sectors in which the firms operate, and ownership. Our main source of information is the Chilean Superintendency of Securities and Insurance (the *Superintendencia de Valores y Seguros,* or SVS),which requires all firms categorized as corporations to disclose their accounting information using a standardized format (the *Ficha Estadística Codificada y Uniforme,* or FECU). We use nonconsolidated data, so that investments in subsidiaries are reported in a separate account and not as a part of the aggregate stock of fixed assets.

Data on the currency composition of liabilities and assets is not recorded directly in the FECUs, but is reported in the notes attached to each firm's annual financial statistics. These notes are not standardized and are not available in an electronic format. We therefore start with the data on foreign currency liabilities assembled by Benavente, Johnson, and Morandé (2003).[6] We then input data on foreign currency assets and derivatives collected from each of the notes mentioned above.

For our estimates, we use a sample restricted to the nonfinancial firms for which foreign-currency data are available. Table 1 shows the number of observations in the final sample per year, as well as descriptive statistics for the main variables we use. The size of the sample changes as new firms are incorporated into the SVS database.

6. This database is part of a broader effort by the IDB to put together data on firm-level currency composition of liabilities. For more details, see Galindo, Panizza, and Schiantarelli (2003).

Table 1. Descriptive Statistics

Variable	*Observations*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Investment in fixed capital over lagged assets	1,326	0.038	0.149	–2.200	1.071
Dollar debt over lagged assets	1,183	0.093	0.139	0.000	1.013
I (firm has dollar debt)	1,179	0.651	0.476	0.000	1.000
Dollar assets over lagged assets	1,186	0.058	0.164	–0.029	1.008
Net foreign exchange derivatives position over lagged assets	1,325	0.007	0.043	–0.153	0.562
I (firm has derivatives)	1,326	0.141	0.348	0.000	1.000
Exposure (dollar debt – forwards – dollar assets) over lagged assets	1,181	0.027	0.169	–1.008	0.648
Cash flow over lagged assets	1,326	0.072	0.185	–1.584	3.209
Exports over lagged assets	1,309	0.053	0.156	0.000	1.379
Exports over sales	1,309	0.098	0.229	0.000	1.027
Lagged capital over assets	1,326	0.772	0.451	0.000	4.833

Source: See appendix.

Our main measure of firm performance is investment in fixed capital, measured as the change in gross fixed assets. Accounting standards in Chile only contemplate revaluations of fixed assets for consumer price index (CPI) inflation, making it possible to separate investment from changes in the accounting valuation of capital goods.

Our main measure of currency exposure is foreign currency debt (D^*), the book value of foreign currency liabilities converted into local currency. Chilean accounting standards dictate that conversion of debt from foreign to local currency values be carried out using the exchange rate at the time at which the balance sheet is reported. We augment this variable with a measure of foreign currency assets (A^*), which is the local currency value of fixed assets that are indexed to a foreign currency instead of the local CPI, and the nominal value of outstanding currency derivatives contracts with domestic banks. To our knowledge, this is the first comprehensive dataset of emerging market firms to include information on the currency composition of both sides of the balance sheet.

One of the main questions we seek to answer in this paper is whether firms match the currency composition of assets and liabilities. To answer this question, we construct additional variables that proxy for α. The first is a tradable dummy, that takes a value of one for firms in agriculture, manufacturing, and mining and zero otherwise. Data on the sector composition of output is reported in the FECU, and we also add firm-level data on FOB export shipments collected from the Chilean Customs Office. We convert the export data from dollars to pesos using the year-end exchange rate.

To explore the relation between investment and currency exposure, we control for additional determinants of investment. The first of these is earnings, defined as net operational earnings plus depreciation. Since we wish to identify the effects of leverage (in particular, leverage in dollars) on investment, we follow Lang, Ofek, and Stulz (1996) in using a measure of earnings that does not depend on the firm's debt choice. This measure of cash flow also excludes gains (or losses) from exchange rate changes, which allows us to isolate the effects of exchange rate fluctuations on revenues and costs from its effects on the valuation of assets and liabilities.

Some of our specifications include measures of the ratio of the book to market value of assets and average q ratios as control variables. Both of these require data on market capitalization. We obtain this data directly from the Chilean stock exchange. In all cases, the values we use correspond to closing prices and outstanding shares in December.

Data on the use of derivatives at the firm level is scarce in the literature in general, mostly because regulatory entities have only recently imposed the obligation to report this kind of transaction. Chile is no exception. Homogeneous data on derivative use from the notes to the financial statements is only available since 2001.[7] To overcome this limitation, we obtained access to an additional source of derivative data: the register of notional values of foreign currency derivatives outstanding with Chilean banks (F^*). The main advantage of this series is that it is available since 1993. On the other hand, derivative transactions that do not include a domestic bank are excluded. This seems to be a fairly minor problem in our sample. Differences in 2001 and 2002 between the nominal amounts reported by firms in the notes to their financial statements and the notional amounts reported by banks are minimal.

Although we use the longer derivatives series from the Central Bank of Chile in all of the regressions, the notes to the financial statements provide interesting additional information on the use of currency derivatives in Chile in. The notes provide contract-by-contract information for all derivative transactions, covering all derivative instruments and underlying assets. Based on the data for the period

7. In October 2000, the SVS modified the regulations that define how to report derivative transactions in the complementary notes to the balance sheet data. In the new norm, the SVS explicitly clarifies the obligation to report derivatives and identifies which information to disclose. Before 2000, the norm was not clear enough to ensure that every single transaction would be informed, leaving this decision up to the firm. The data that comes from the complementary notes is thus trustworthy only since 2001.

2001–02, we observe three important stylized facts. First, Chilean firms use derivatives contracts primarily to cover exchange rate exposure. In fact, 73 percent of the total number of contracts reported in the period (385) corresponds to foreign currency contracts. Second, the most common instrument used to cover exchange rate risk is the forward. If we restrict our sample to foreign currency contracts, 86 percent are forwards contracts. Third, derivatives contracts are established over relatively short periods, with an average duration of less than one year (ten months).

Finally, we build four indicator variables to control for differences in firm ownership. The variable ADR measures whether the firm's stock trades on a U.S. stock exchange in the form of American depositary receipts (ADRs) in any given year. The variable GRUPO is a dummy variable that indicates whether a firm was part of a conglomerate (as defined by the SVS) in 2003. AFP is dummy variable that takes the value of one if the Chilean pension fund administrators (AFPs) may hold stock from the firm without restrictions. We construct the variable using information provided by the Superintendcy of Pension Fund Administrators (the *Superintencia de Administradores de Fondos de Pension,* or SAFP). We exclude the stocks of financial intermediaries such as banks, pension funds, insurance companies, mutual fund administrators, and investment funds administrators on the stock exchange. The last of the ownership variables is FOREIGN, a dummy variable for firms controlled by foreign multinationals. This variable is constructed in two steps. First, we pooled the most recent information from the SVS, Economática, and Worldscope on shareholder composition. We then used Lexis Nexis, the corporate affiliations Database, and the Mergers and Acquisitions Database to cross-check the nationality of the main shareholder or parent company. Of these four variables, all but GRUPO are time varying.

We modify all accounting variables in the followings three ways. First, we inflate or deflate our data to 1996 values using December-to-December changes in the consumer price index. Second, we drop all firm-year observations if the accounting data are not self-consistent, because data on foreign currency liabilities and assets are inputted by hand. In particular, we drop observations if the ratios of dollar debt over total liabilities, dollar assets over total assets, exports over total sales, and short-term liabilities over total liabilities are outside the range (–0.1, 1.1). We also drop observations if the ratio of forward position over total assets is outside the range (–1.1, 1.1). Finally, we drop outliers of our key left-hand-side and right-hand-side variables. To do so, we construct a z score using the sample mean and standard deviation, and we then drop firm-year observations that have $|z| > 2$.

Because we are interested in the effects of a devaluation on firms holding dollar debt, in the analysis below we interact D^*, A^*, and F^* with changes in the real exchange rate, Δe. Our definition of e (the nominal exchange rate against the U.S. dollar, scaled by the local CPI) is consistent with the inflation adjustments described above. In all the specifications we report, we measure Δe as the log change in the real exchange rate between Decembers of successive years. Using e on inflation-adjusted values of debt is equivalent to using the nominal exchange rate on current values. According to this definition, a devaluation leads to a higher value of e.

4. The Effects of Currency Exposure on Firm Performance

Our empirical specification in this section can be motivated with a simple framework in which the optimal stock of capital is a function of the real exchange rate (due to the competitiveness effect) and the real value of previous-period liabilities (due to a balance sheet effect). Specifically, assume that the log of the optimal capital stock, k_t^*, is given by

$$k_t^* = \alpha e_t - \theta P_t ,$$

where α measures the elasticity of k_t^* to the real exchange rate, θ represents the elasticity of the log of the optimal capital stock to leverage, and P_t is the real (inflation-adjusted) value of previous-period liabilities, which serves as a proxy for net worth. In the presence of quadratic adjustment costs, investment (I_t) will be a fraction (λ) of the gap between the frictionless capital stock and lagged capital, so that

$$I_t = \lambda(\alpha e_t - \theta P_t - k_{t-1}). \tag{2}$$

The key mechanism we wish to test is how a depreciation alters investment by inflating the domestic-currency value of debt. To incorporate this mechanism in the previous equation, consider that the real value of previous-period liabilities is given by

$$P_t \approx D_{t-1}^* \Delta e_t + P_{t-1} , \tag{3}$$

where D^*_{t-1} is lagged dollar debt and Δe_t the log change in the real exchange rate. The real value of the firm's debt rises if it holds foreign currency debt and the exchange rate goes up faster than the domestic-price level. This is, of course, a purely mechanical effect.

Our basic empirical specification (for firm i in year t) follows directly from equations (2) and (3):

$$I_{i,t} = -\gamma\left(D^{*}_{i,t-1}\Delta e_t\right) + \delta P_{i,t-1} + \lambda\left(\alpha_i e_t\right) - \lambda k_{i,t-1} + \phi D^{*}_{i,t-1} + y_t + \omega_t + \upsilon_{i,t}\ , \qquad (4)$$

We estimate versions of equation (4) on our sample of firms for the period 1995–2003. The key explanatory variable in our analysis is the interaction of lagged dollar debt, $D^*_{i,t-1}$, with the log change in the real exchange rate, Δe_t.

We can interpret the estimated coefficient on this interaction in two ways. The first, which follows directly from the framework presented in this section, is the effect of exogenous changes in the real value of total liabilities on firm investment. The second follows from a difference in difference approach, in which the estimated coefficient on the interaction between lagged dollar debt and the change in the real exchange rate ($D^*_{i,t-1} \cdot \Delta e_t$) indicates whether firms holding dollar liabilities invest significantly less than their counterparts in periods following a devaluation.

In addition to the ($D^*_{i,t-1} \cdot \Delta e_t$) interaction, we include lagged foreign-currency-denominated debt to absorb any preexisting differences among firms with different levels of dollar indebtedness. Such differences might have prevailed in the absence of movements in the real exchange rate(for example, if expanding firms were more likely to issue dollar debt than stagnant ones). We also include sets of year and firm-specific dummies, y_t and ω_i. The year dummies capture aggregate shocks common to all firms in our sample, including changes in the real exchange rate. The firm-level dummies capture time-invariant differences across firms in the optimal level of capital. Finally, we include a series of proxies for α_i, the elasticity of k^* to the real exchange rate. We discuss these proxies and additional controls below.

4.1 Main Results

Table 2 presents estimates of the reduced effect on investment of holding dollar debt during a depreciation. The key variable here is the interaction between lagged dollar debt and the change in the real exchange rate. This interaction will indicate whether firms holding dollar debt invest relatively less that those holding peso debt in periods following a depreciation.

Table 2. Effect of Exchange Rate Exposure on Investment, 1995–2003[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Interaction						
Dollar debt x (Δ log real exchange rate)	0.009	–0.020	–0.049	–0.043	–0.428**	–0.453***
	(0.155)	(0.126)	(0.109)	(0.112)	(0.205)	(0.170)
Main effect						
Dollar debt	0.014	0.015	0.026	0.025	0.021	0.032
	(0.063)	(0.059)	(0.060)	(0.057)	(0.060)	(0.058)
Total debt	–0.097*	–0.095*	–0.100*	–0.099*	–0.098*	–0.101*
	(0.057)	(0.057)	(0.057)	(0.057)	(0.058)	(0.057)
Control						
Exports		–1.239		0.001		
		(1.191)		(1.229)		
Exports x (log real exchange rate)		0.205		0.004		
		(0.179)		(0.187)		
Tradable x (log real exchange rate)			0.169***	0.170***		0.152***
			(0.059)	(0.061)		(0.057)
Dollar assets					0.013	0.009
					(0.029)	(0.029)
Dollar assets x (Δ log real exchange rate)					0.847***	0.791***
					(0.210)	(0.231)
Summary statistic						
No. observations	1.326	1.326	1.326	1.326	1.326	1.326
R^2	0.26	0.26	0.26	0.26	0.26	0.27

Table 2. (continued)

Explanatory variable	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Interaction						
Dollar debt x (Δ log real exchange rate)	–0.451**	–0.494**	–0.492**	–0.353**		
	(0.201)	(0.206)	(0.208)	(0.164)		
Exposure x (Δ log real exchange rate)					–0.265**	–0.274***
					(0.117)	(0.097)
Main effect						
Dollar debt	0.011	0.009	0.009	0.010		
	(0.043)	(0.045)	(0.045)	(0.043)		
Exposure					–0.016	–0.018
					(0.020)	(0.023)
Total debt	–0.099*	–0.099*	–0.099*	–0.100*	–0.096*	–0.090*
	(0.057)	(0.057)	(0.057)	(0.056)	(0.055)	(0.049)
Control						
Tradable x (log real exchange rate)	0.113**	0.113**	0.113**	0.110***	0.106**	0.117**
	(0.044)	(0.044)	(0.044)	(0.042)	(0.042)	(0.046)
Dollar assets	0.013	0.013	0.013	0.030		
	(0.026)	(0.026)	(0.026)	(0.022)		
Dollar assets x (Δ log real exchange rate)	0.693***	0.711***	0.710***	0.224*		
	(0.203)	(0.202)	(0.203)	(0.117)		
Cash flow from operations	0.324**	0.324**	0.324**	0.321**	0.322**	0.307**
	(0.145)	(0.145)	(0.145)	(0.148)	(0.148)	(0.132)
Net long derivative position		0.016	0.018	0.015		
		(0.062)	(0.061)	(0.060)		
Net long derivative pos. x		0.404*		0.382		
(D log real exchange rate)		(0.236)		(0.256)		

Table 2. (continued)

Explanatory variable	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Net long derivative x (Δ log real exchange rate unexpected)			0.355* (0.214)			
Lagged capital stock						–0.168** (0.071)
Lagged capital stock x (Δlog real exchange rate) x I (account US$)				0.609*** (0.185)	0.580*** (0.197)	0.561*** (0.171)
Summary statistic						
No. observations	1.326	1.326	1.326	1.326	1.326	1.326
R^2	0.36	0.36	0.36	0.37	0.37	0.41

Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The dependent variable is the change in the CPI-adjusted stock of fixed capital. The regressions are variants of equation 4 in the text, using OLS and year fixed effects. All independent accounting variables (with the exception of cash flow from operations) are once lagged. All accounting variables are scaled by once-lagged total firm assets. I (account US$) is a dummy for firms that carry their accounting in dollars. Exposure is the dollar debt net of derivatives and dollar assets. The baseline real exchange rate is defined as the nominal peso-dollar exchange rate divided by the domestic CPI. Unexpected changes in the real exchange rate are built assuming uncovered interest rate parity, as described in the text. Net derivative positions are the notional values of currency derivative positions with domestic banks. For detailed sources and descriptions, see the appendix. Standard errors adjusted for clustering by year are reported in parentheses.

The sample covers the period 1995–2003. It includes two large depreciations in 1999 and 2001 (both approximately 10 percent in real terms) and a large appreciation in 2003. In addition, the levels of foreign currency debt exhibit substantial cross-firm variation, which allows us to identify differential responses of firms to a depreciation (or appreciation).

All specifications include firm fixed effects to control for time-invariant firm differences in the optimal capital stock, as well as year dummies to capture the shocks common to all firms. Following equation (4), we also include the lagged dollarization ratio to control for previous-period differences in firms with higher or lower dollar debt. Lagged total leverage is included as an additional control.

Column 1 includes only the interaction between dollar debt and the change in the real exchange rate ($D^* \cdot \Delta e$). As in previous studies for Chile, the estimated coefficient is not negative: firms with more dollar debt do not invest relatively less in periods following a depreciation. At the same time, the estimated coefficient on lagged leverage is negative as expected, suggesting a negative balance sheet effect from outstanding debt commitments.

As discussed above, the estimated coefficient on ($D^* \cdot \Delta e$) will be biased upwards if firms holding dollar debt also see their current and future profits expand following a depreciation. To control for this bias, columns 2 through 4 include interactions between changes in the real exchange rate and two proxies for the elasticity of income to the real exchange rate a: the ratio of exports over assets and a dummy for firms in the tradable sector. In both cases the estimated coefficient on the interaction term is positive—significantly so in the case of the tradable dummy interaction. The estimated coefficient on ($D^* \cdot \Delta e$) remains insignificant, although marginally more negative that in column 1.

The discussion so far in this section, and indeed in most of the empirical literature on firm-level currency balance sheet effects, focuses on dollar debt as the only mechanism through which a change in e can have balance sheet effects. By doing so, we are ignoring the fact that firms may also hold dollar-denominated assets, such as current assets in a foreign bank or offshore investments, and that the inflated value of these sources of income following a depreciation will offset the negative balance sheet effect of dollar liabilities. This is a necessary simplification in many cases given the absence of data on the currency composition of assets, but it can introduce substantial biases into the estimation of the balance sheet effects of a depreciation in a country such as Chile, where domestic firms hold significant foreign assets. In our sample, the average ratio of dollar assets to total assets is 5.8 percent, which is very close to the 9.3 percent average of dollar liabilities.

With this in mind, we include an additional interaction between dollar assets and the change in the real exchange rate ($A^* \cdot \Delta e$) (see columns 5 and 6). As expected, the coefficient on the interaction is positive, since firms holding dollar assets see their fixed capital investment go up by relatively more than firms holding only peso assets. This, in itself, suggests a balance sheet effect: firms whose liabilities fall relative to total assets are perceived as less risky, face a lower cost of external finance, and consequently have a higher optimal capital level than do firms with a stable or rising ratio of liabilities to total assets.

Once the effect of ($A^* \cdot \Delta e$) is considered, the estimated coefficient on ($D^* \cdot \Delta e$) falls, becoming negative and significant. This confirms our prior: the insignificant coefficient on ($D^* \cdot \Delta e$) in column 1, and in many of the empirical papers so far, is due to omitted variables that are positively correlated with dollar debt. The reason is matching. Firms that hold dollar debt also have dollar assets (which offsets the balance sheet effect) and export a larger share of their output (which also offsets the negative balance sheet effect).

Finally, we control for differential effects of changes in the exchange rate on firm cash flow that are not captured by the interactions between tradable sectors and the exchange rate and exporting firms and the exchange rate. The specification reported in column 7 includes a measure of cash flow from operations. As expected, the cash flow variable is positive and highly significant, measuring relaxed credit constraints stemming from improved net worth and changes in the marginal product of capital.

Our results presented thus far suggest, first, that firms match the currency composition of their income and assets with that of their liabilities. As a result, those firms holding dollar debt during a depreciation see the value of their profits and assets expand in line with the value of their liabilities. The negative balance sheet effect of the exchange rate on debt is offset by the positive balance sheet effect of the exchange rate on assets and profits. Second, our results suggest substantial balance sheet effects: exogenous changes in leverage brought about by inflated peso values of debt have significant effects on investment. In our sample, the investment-to-asset ratio of firms holding 50 percent of their debt in foreign currency is 5 percent of assets lower that their peso-indebted counterparts following a 20 percent real depreciation (similar to the 2001 depreciation in Chile). This difference is sizeable considering a sample mean of 4 percent. Third, from a measurement perspective, these result highlight the importance of having a measure of total balance sheet exposure to determine the effect of a depreciation in investment and output.

The Chilean derivatives market, in particular the market for currency derivatives, has expanded substantially in recent years. Although average net positions are still small in relation to total assets, they are no longer negligible, and in the case of some firms, they substantially alter the level of net (or uncovered) dollar debt. To explore the effects of these derivative positions on firm-level investment, column 8 includes an interaction between the real depreciation and net foreign exchange derivative position over assets in the previous period ($F^* \cdot e$). The estimated coefficient in positive and significant, meaning that in periods following a depreciation, firms holding long foreign exchange derivative positions invest relatively more than firms that do not.

Arguably, what matters for the effect of derivatives on output is not the total change in the real exchange rate, but the deviation from the change preestablished in the contract. We address this concern by using interest rate differentials to construct a measure of deviations of realized depreciation from the depreciation implicit in the forward contract, Δe^u. Assuming covered interest parity,

$$\Delta e_t^u = \Delta e_t - \left(r_{t-1} - r_{t-1}^* \right),$$

where r_{t-1} is the rate on UF-indexed debt for 90–365 days and r^*_{t-1} is the dollar lending rate in the domestic financial system for the same period.[8] According to this construction, most of the large depreciations were unexpected, even the 1999 depreciation. We therefore do not expect our results to vary substantially when we include an interaction of derivative positions with Δe_t^u. Indeed, the estimated coefficient (reported in column 9) is very similar to our previous result using total exchange rate movements.

A peculiarity of Chilean accounting norms is that certain firms are allowed to keep their accounts in dollars. Because these firms are allowed to revalue their fixed assets by changes in the nominal exchange rate, part of our measure of investment may simply be driven by changes in the prices of preinstalled assets. To correct for this, we introduce an

8. The *Unidad de Fomento* (UF) is an inflation-indexed unit of account that is commonly used in Chilean financial transactions.

interaction between the lagged capital stock and the change in the real exchange rate for those firms with dollar accounting (see column 10). This component controls for the effects of mechanical revaluations on investment. The estimated coefficient on the ($A^* \cdot \Delta e$) interaction falls considerably, but it is still significant. The estimated coefficient on the ($D^* \cdot \Delta e$) interaction remains negative and statistically significant.

The absolute value of the estimated coefficients on dollar debt, dollar assets, and currency derivatives are similar, and an F test fails to reject the hypothesis that all three coefficients are equal. We thus build an accounting measure of currency mismatch (E^*), equal to dollar debt net of assets and the net long position in foreign exchange derivatives $E^* = D^* - A^* - F^*$. In column 11, we repeat our baseline estimation of investment and include an interaction between exposure and changes in the real exchange rate ($E^* \cdot \Delta e$). As expected, the estimated coefficient on the interaction ($E^* \cdot \Delta e$) is negative and significant at conventional confidence level. The estimated coefficient implies that a difference in exposure of 50 percent of assets will lead (all things equal) to nearly 3 percent lower investment if the currency depreciates by 20 percent.

Finally, in column 12 we deviate from the difference-in-differences approach we have followed so far and estimate an empirical specification that follows directly from equation (4). To do so, we include the lagged capital stock. The main result remains unchanged: the estimated coefficient on ($E^* \cdot \Delta e$) is negative and significant. As expected, the estimated coefficient on lagged capital stock is negative and significant. We use the specification from column 12 as our baseline result in the tables that follow.

Summing up, we find evidence of sizeable balance sheet effects and of firm-level matching. These results are robust to a series of alternative specifications and firm level controls.[9]

4.2 Sensitivity Analysis

By focusing exclusively on exchange rate fluctuations, we have ignored the fact that many of the exchange rate changes in our sample occur simultaneously with changes in the supply (and cost) of foreign and domestic credit. For example, firms holding dollar debt might be

9. In addition to the specification reported here, we carried out the following additional robustness tests: estimates using lagged investment and interaction of Dln(real exchange rate) with exports and tradables; estimates using lagged investment and firm fixed effects based on the Arellano-Bond methodology; estimates that drop all observations in which E^* is zero, to control for right-hand-side variable censoring bias. In all cases, our main results remain qualitatively unchanged.

less sensitive to changes in domestic interest rates than firms holding peso liabilities. If domestic rates rise in periods of a depreciation because the Central Bank is defending the currency, then our coefficient on the ($E^* \cdot \Delta e$) interaction would be biased upward (toward zero). Alternatively, the large negative coefficient on the ($E^* \cdot \Delta e$) interaction could be the result of rising external capital costs and a tightening of foreign credit constraints that coincide with periods of depreciation.

Furthermore, exposure to exchange rate fluctuations is by no means the only aggregate shock that affects firm output and investment decisions. It is therefore informative to see how aggregate credit shocks (domestic and foreign) have differential effects on firms with different financial structures. To control for changing credit conditions, we estimate the investment regressions including an indicator of domestic credit conditions (namely, the domestic interest rate) and an indicator of external credit conditions (the return on the Emerging Market Bond Index, or EMBI, bond basket). In each case, we interact the macroeconomic variable with our measure of currency exposure and the ratio of dollar debt to total assets. We also interact the macroeconomic variables with a measure of the firm's maturity mismatch.[10] The risk of maturity mismatch for emerging market firms has received almost as much attention in recent years as the risk of currency mismatch. Although business assets are (stereotypically) installed for the long term and are therefore illiquid, capital market frictions and distortions may induce firms to issue debt with relatively short maturity. Should aggregate credit conditions shift suddenly, these firms would be unable to renew their debt and thus might have to curtail investment and perhaps liquidate.

Table 3 shows the results obtained for investment after including aggregate credit variables. The ($E^* \cdot \Delta e$) interaction is significant and negative even after we include this additional set of controls. Moreover, the point estimates change only slightly. Most of the additional coefficients estimated have the expected signs, but they are not significant at conventional confidence levels. We do, however, obtain interesting results for the interactions with the maturity mismatch variable. All things equal, firms with more short-term debt relative to short-term assets react more strongly to hikes in the domestic interest rates than do firms with a lower ratio.

10. We tested the robustness of our results to a series of additional interactions (not report in the table). At the firm level we used short term debt, log(assets), and total leverage. At the macroeconomic level, we used net capital inflows, changes in the stock of bank loans to the private sector, a dummy for sudden stops (as defined by Calvo, Izquierdo, and Mejía, 2004), and London interbank offered rates (LIBOR) on dollar loans. These results are available on request.

Table 3. Changes in Aggregate Credit Conditions[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Interaction						
Exposure x (Δ log real exchange rate)	–0.253***	–0.292**	–0.248***	–0.267***	–0.283***	–0.291***
	(0.081)	(0.125)	(0.084)	(0.091)	(0.100)	(0.095)
Baseline control						
Exposure	0.005	–0.065**	–0.006	–0.007	–0.018	–0.019
	(0.041)	(0.033)	(0.025)	(0.024)	(0.023)	(0.023)
Cash flow from operations	0.307**	0.307**	0.308**	0.307**	0.307**	0.303**
	(0.132)	(0.132)	(0.132)	(0.132)	(0.132)	(0.133)
Tradable x (Δ log real exchange rate)	0.118**	0.113**	0.116**	0.117**	0.111**	0.137***
	(0.046)	(0.047)	(0.047)	(0.046)	(0.047)	(0.049)
Lagged capital stock	–0.168**	–0.168**	–0.169**	–0.169**	–0.171**	–0.171**
	(0.071)	(0.071)	(0.071)	(0.071)	(0.072)	(0.072)
Total debt	–0.09*	–0.09*	–0.087*	–0.087*	–0.106*	–0.108*
	(0.049)	(0.049)	(0.049)	(0.049)	(0.056)	(0.057)
Additional control						
Lagged capital stock x (Δ log real exchange rate) x I (account US$)	0.558***	0.567***	0.56***	0.554***	0.569***	0.563***
	(0.169)	(0.169)	(0.169)	(0.173)	(0.169)	(0.164)
Exposure x EMBI yield	–0.174					
	(0.296)					
Exposure x domestic interest rate		0.666				
		(0.494)				
Dollar debt			0.025	–0.04		
			(0.070)	(0.091)		
Dollar debt x EMBI yield			–0.406			
			(0.395)			

Table 3. (continued)

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Dollar debt x domestic interest rate				0.151		
				(0.931)		
Maturity mismatch					–0.007	0.136***
					(0.073)	(0.045)
Maturity mismatch x EMBI yield					0.291	
					(0.502)	
Maturity mismatch x domestic interest rate						–1.46***
						(0.552)
Summary statistic						
No. observations	1.326	1.326	1.326	1.326	1.326	1.326
R^2	0.41	0.41	0.41	0.41	0.41	0.41

Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.
a. The dependent variable is the change in the CPI-adjusted stock of fixed capital. All regressions are estimated using OLS, with year fixed effects. All independent accounting variables (with the exception of cash flow from operations) are once lagged. All accounting variables are scaled by once-lagged total firm assets. Exposure is dollar debt net of derivatives and dollar assets. I (account US$) is a dummy for firms that carry their accounting in dollars. Maturity mismatch is defined as the difference between current liabilities and current assets, scaled by total assets. Macroeconomic variables (the real exchange rate and domestic and international interest rates) are from the current period (that is, concurrent with the left-hand-side investment variable). The real exchange rate is defined as the nominal exchange rate divided by the domestic CPI. The domestic interest rate is the three-month rate of return on 30- to 89-day UF-denominated loans in the domestic financial system. For detailed sources and descriptions, see the appendix. Standard errors adjusted for clustering by year are reported in parentheses.

Differential balance sheet effects across firms

The sample-average effect presented above was strongly negative, but this might mask differences in balance sheet effects across groups of firms. Indeed, we would expect the estimated coefficient on the $(E^* \cdot \Delta e)$ interaction to be relatively smaller (in absolute terms) for firms that we would consider a priori less credit constrained or financially stronger.

Table 4 partitions the sample by predetermined firm characteristics. Column 1 replicates our baseline results, while columns 2 through 5 introduce an additional interaction between the $(E^* \cdot \Delta e)$ variable and one of four indicator variables. The first of these is a dummy that takes a value of one for firms that are eligible to be included in the AFP portfolio. Two previous studies for Chilean firms have found that investment by firms in this category is less correlated with cash flow and less sensitive to leverage than is the investment of firms that are not in the AFP portfolios (Medina and Valdés, 1998; Gallego and Loayza, 2000). The additional three dummy variables were described above: a dummy for foreign ownership, a dummy for firms with ADRs, and a dummy for firms belonging to a financial conglomerate.[11] All the specifications also include the indicator variable, its interaction with total leverage, and its interaction with D*e*, although only the coefficients on $(E^* \cdot \Delta e)$ and the triple interaction are reported. Structuring the specification in this manner allows us to estimate how the effect of $(E^* \cdot \Delta e)$ among the indicated set of firms differs from the rest of the sample.

When we interact our measure of exposure with the AFP dummy and the ADR dummy, the estimated coefficient is positive, suggesting that less credit constrained firms are less vulnerable to the balance sheet effects of currency exposure. The interaction has the opposite sign, however, in the case of the foreign and financial conglomerate dummies. These regressions have been estimated very imprecisely, so these findings must be taken with caution. We have no explanation for the results of either the foreign dummy or the financial conglomerate dummy.

5. Foreign Currency Hedging by Chilean Nonfinancial Firms

The previous section provides empirical support of a strong balance sheet effect arising from the interaction of foreign debt and exchange rate depreciations after controlling for differences in the composition of

11. We exclude those periods from the sample in which a firm changes categories. This explains the smaller sample than in previous specifications.

Table 4. Effect of Exposure across Firm Categories[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Exposure x (Δ log real exchange rate)	–0.287***	–0.451	–0.293*	–0.310**	0.250
	(0.092)	(0.295)	(0.154)	(0.123)	(0.369)
Exposure	–0.023	–0.026	–0.025	–0.023	–0.025
	(0.023)	(0.033)	(0.023)	(0.024)	(0.024)
Total debt	–0.089*	–0.090	–0.091*	–0.093*	–0.091*
	(0.049)	(0.055)	(0.050)	(0.049)	(0.050)
Cash flow from operations	0.309**	0.275**	0.307**	0.308**	0.308**
	(0.131)	(0.135)	(0.132)	(0.132)	(0.131)
Lagged capital stock	–0.167**	–0.179**	–0.168**	–0.169**	–0.167**
	(0.071)	(0.091)	(0.071)	(0.072)	(0.071)
Lagged capital stock x (Δ log real exchange rate)	0.577***	0.542**	0.582***	0.553***	0.533*** x I
(account US$)	(0.179)	(0.211)	(0.186)	(0.188)	(0.182)
I (AFP) x exposure x (Δ log real exchange rate)		0.343			
		(0.394)			
I (foreign) x exposure x (Δ log real exchange rate)			–0.057		
			(0.606)		
I (ADR) x exposure x (Δ log real exchange rate)				0.185	
				(0.452)	
I (GRUPO) x exposure x (Δ log real exchange rate)					–0.750
					(0.559)
Summary statistic					
No. observations	1.326	1.102	1.323	1.308	1.326
R^2	0.41	0.4	0.41	0.41	0.41

Source: Authors' calculations, based on accounting data from SVS and macroeconomic data from various sources.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The dependent variable is the change in the CPI-adjusted stock of fixed capital. All regressions are estimated using OLS, with year fixed effects. All independent accounting variables (with the exception of cash flow from operations) are once lagged. All accounting variables are scaled by once-lagged total firm assets. Exposure is dollar debt net of derivatives and dollar assets. I (account US$) is a dummy for firms that carry their accounting in dollars, I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. The baseline real exchange rate is defined as the nominal peso-dollar exchange rate divided by the domestic CPI. The number of observations changes because periods in which firms change categories are excluded from the sample. Standard errors adjusted for clustering by year are reported in parentheses.

the balance sheet and net operational income. The evidence also suggests that Chilean nonfinancial corporations actively use foreign debt as a hedge for other sources of foreign currency exposure. This section studies the hedging behavior of Chilean firms during the sample period. We estimate a set of regressions to examine the extent of currency matching in our sample and the relation between hedging and those variables identified in the corporate finance literature to explain risk aversion in nonfinancial corporations.

5.1 Dollar Debt and Productive Structure

In this section, we evaluate the first prediction of the mean variance framework we presented in the previous section—namely, that firms match the currency composition of their liabilities with that of their assets and income. To do so, we estimate the following equation on pooled firm-level data for the period 1996–2002

$$\beta_{it} = \delta\alpha_{it} + \upsilon_{it}\ , \tag{5}$$

in which for firm i in period t, β_{it} is a measure of dollar debt to total assets and α_{it} is the set of variables introduced in the previous section that proxy for the elasticity of firm income to the real exchange rate (specifically, direct exports as a share of total sales; a dummy variable that takes a value of one if the firm is in the agriculture, mining, or manufacturing sector; and the ratio of dollar-denominated assets to total assets).

Table 5 reports the ordinary least squares (OLS) estimation for the ratio of dollar debt to assets. Column 1 includes the tradable dummy (agriculture, mining, or manufacturing), while column 2 includes a set of dummies for one-digit International Standard Industrial Classification (ISIC) sectors (not reported). Because β_{it} is left-hand censored at zero, we also estimate equation (5) using a Tobit method (see columns 3 and 4). In all four specifications, the estimated coefficients on exports and dollar assets are positive and highly significant. The coefficients are also sizeable. Using the estimated coefficients from column 1, we find that the fraction of dollar-denominated liabilities over assets is 6.5 percent higher in firms that export 50 percent of their output than in firms that sell their output domestically. Similarly, firms with a 50 percent share of dollar-denominated assets have, on average, ratios of dollar debt to assets that are 13 percent higher than firms with primarily peso- or UF-denominated debt. The tradable dummy is positive and

Table 5. Dollar Debt and Production Structure, 1996–2002[a]

	Dollar debt / total assets				Dollar debt / total debt				I (dollar debt)		Net dollar debt / total assets	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Dollar assets / total assets	0.269***	0.264***	0.330***	0.344***	0.586***	0.629***	0.702***	0.788***	7.466***	8.127***	0.274***	0.269***
	(0.052)	(0.051)	(0.034)	(0.034)	(0.082)	(0.079)	(0.070)	(0.069)	(2.332)	(2.393)	(0.051)	(0.050)
Exports / sales	0.128***	0.122***	0.174***	0.196***	0.356***	0.419***	0.441***	0.568***	1.894***	2.583***	0.149***	0.142***
	(0.033)	(0.031)	(0.026)	(0.023)	(0.069)	(0.063)	(0.052)	(0.048)	(0.466)	(0.549)	(0.033)	(0.030)
Tradable	–0.008		0.027**		0.077*		0.157***		0.547***		–0.008	
	(0.018)		(0.013)		(0.040)		(0.027)		(0.184)		(0.017)	
Summary statistic												
No. observations	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.085	1.085	1.075	1.075
R^2	0.17	0.17			0.29	0.27					0.21	0.21
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Cluster rut	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	Tobit	Tobit	OLS	OLS	Tobit	Tobit	Probit	Probit	OLS	OLS

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. This table reports the estimates of equation 5 in the text. The estimation method for each regression is reported in the bottom row. The dependent variable is as detailed in each column. Net dollar debt is dollar debt net of derivative positions. The net derivative position is the notional value of the net long position of foreign exchange derivatives with domestic banks. Tradable firms are those in ISIC sectors 1 through 3 (agriculture, mining, and manufacturing). Standard errors are in parentheses.

significant in column 3: even after we control for dollar assets and exports, dollar liabilities are 3 percent higher (as a percent of total assets) than in nontradable sectors.

We obtain qualitatively identical results when we measure β as the ratio of dollar debt to total debt (in columns 5 through 8), when we replace β with an indicator variable for firms that hold dollar debt (column 9 and 10), and when we measure β as dollar debt over assets net of derivative positions (columns 11 and 12).

In sum, we find strong evidence that firms match the currency composition of their debt with that of their accounting assets and income streams. Effective foreign currency exposure is therefore substantially smaller than what foreign currency debt suggests, so that in periods of depreciation we expect the negative balance sheet effects of dollar debt to be offset (or reversed) by the positive balance sheet effects of dollar assets and income.

5.2 Structural Determinants of Derivative Use

What ultimately matters for firm performance is the net exposure to exchange rate shocks. Nevertheless, in our sample derivative positions are relatively small vis-à-vis total dollar debt, so the results for net dollar debt (dollar debt net of long foreign exchange derivative positions) are driven to a large extent by the debt component. We therefore present some additional results for the determinants of derivative use in table 6. In columns 1 and 2, the left-hand-side variable is the nominal value of net derivative positions over total assets; in columns 3 and 4, the left-hand-side variable is an indicator variable for firms holding any form of foreign exchange derivative.

The estimated coefficient on dollar debt is positive and significant at conventional confidence levels in all specifications. Firms holding dollar debt hold larger long positions in foreign exchange derivatives and are, in turn, more likely to hold any form of foreign exchange derivative than firms that do not hold dollar debt. On the other hand, the estimated coefficients on the ratio of exports to sales and the ratio of dollar assets to total assets are negative and significant only in columns 1 and 2. When we control for dollar debt, firms exporting a large share of their sales and firms with a large share of dollar-denominated assets hold significantly lower long derivative positions. The estimated coefficients on exports and dollar assets are not significant in columns 3 and 4 since long positions are treated identically to short positions in the dummy variable.

Table 6. Determinants of Derivative Use[a]

	Net derivatives/ total assets		I (dollar derivatives > 0)	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Dollar assets / total assets	–0.040	–0.039	–0.179	0.122
	(0.013)***	(0.015)***	(0.578)	(0.534)
Exports / sales	–0.037	–0.036	–0.426	–0.008
	(0.009)***	(0.010)***	(0.358)	(0.320)
Tradable	0.000		0.543	
	(0.005)		(0.209)***	
Dollar debt / total assets	0.129	0.129	2.613	2.428
	(0.039)***	(0.040)***	(0.495)***	(0.506)***
Summary statistic				
No. observations	1075	1075	1078	1078
R^2	0.13	0.13	—	—
Sector dummies	No	Yes	No	Yes

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The dependent variable is as detailed in each column. The estimation method is OLS in columns 1 and 2 and probit in columns 3 and 4. The net derivative position is the notional value of the net long position of foreign exchange derivatives with domestic banks. Tradable firms are those in ISIC sectors 1 through 3 (agriculture, mining, and manufacturing). Firm-clustered standard errors are reported in parentheses.3 and 4 since long positions are treated identically to short positions in the dummy variable.

Hence, firms in our sample use derivatives as a complement to real hedges. That is, firms use derivatives to offset the balance sheet risk of dollar debt when their income is not correlated with the real exchange rate.

5.3 Currency Exposure and Risk Aversion

If we control for a and the relative cost of domestic and foreign credit ($\tau + \varepsilon$), the level of exposure to currency shocks should be lower for more risk-averse firms than for risk-loving firms (that is, μ should be higher). To test this prediction empirically, we estimate a measure of excess currency exposure for firms over the period 2000–02. We do this in two stages. In the first, we estimate a regression of dollar debt against our proxies for α (exports, sector, and dollar assets) and against the measure of μ. The first terms capture matching; the second term captures possible correlations between μ and ε, the idiosyncratic component of expected interest. In the second stage, we calculate the absolute deviations between the fitted values from the first stage and observed net dollar debt (net of derivatives), and we then regress them on μ. Table 7 reports the estimated coefficients for the second stage of this estimation for data pooled over the period 2000–02. Each cell reports the estimated coefficient and standard error of univariate regressions of excess net dollar debt against the respective measure of risk aversion or, in the case of the liquidity and investment opportunities variables, the coefficients from a regression that also includes the log of total assets.

Table 7. Corporate Determinants of Currency Exposure[a]

Explanatory variable	*(1)*	*Expected sign of the correlation*
Ownership		
Log (total assets)	0.018***	+
	(0.003)	
I (ADR)	0.081***	+
	(0.024)	
I (foreign)	0.043***	+
	(0.013)	
I (AFP)	0.020**	+
	(0.009)	
I (GRUPO)	0.026**	+
	(0.012)	
Liquidity risk		
Current assets / current liabilities	–0.001*	+
	(0.000)	
Accrued interest / earnings from operations	0.002	–
	(0.002)	
Investment opportunities		
Ratio of lagged investment to assets	0.023	–
	(0.031)	
ln (market-to-book ratio)	–0.004**	–
	(0.002)	

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The table reports estimated coefficients for univariate regressions between excess dollar debt and each of the variables reported in the table. Excess dollar debt is defined as the absolute value of the error term in a regression of dollar debt on firm productive structure, as detailed in column 2 of table 5. In the case of liquidity risk variables and investment opportunities variables, the regression also includes total assets as a control. All liquidity variables are once lagged. I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. Liquidity and investment opportunity variables are as defined in text. Firm ownership data are from various sources. Robust standard errors are in parentheses.

The first section of table 7 reports the estimated coefficients for variables we believe a priori to be correlated with credit constraints. The first is firm size. A series of empirical studies argues that large firms are less credit constrained than small firms because of fixed costs in information disclosure. The estimated coefficient is consistent with this hypothesis: large firms hold net foreign debt positions that are, on average, further from the matching composition than small firms, and these firms are therefore more exposed (in terms of their balance sheet, at least) than small firms. This result is also consistent with the effect of size limitations in the domestic market.

The next two variables measure foreign ownership, either via the U.S. stock market (in the case of firms issuing ADRs) or directly, as part of a foreign conglomerate (in the case of firms owned by foreign corporations). In both cases we estimate a positive and significant coefficient, which suggests that these firms are less credit constrained that their counterparts.

Several empirical papers for Chile group Chilean firms according to their eligibility for pension fund investment, the idea being that firms eligible for AFP portfolios will be less credit constrained than ineligible firms. For a start, firms eligible for AFP investment can access a larger pool of accumulated wealth. In addition, if there are fixed costs to monitoring, then AFP-eligible firms will be closely monitored by the investment managers in the AFPs, reducing the degree of information asymmetry. With this in mind, we include a dummy variable for firms classified by the SAFP as eligible for AFP investment as a proxy for μ.

Finally, we include the GRUPO dummy, for firms belonging to financial conglomerates. We find a positive and significant coefficient, as was the case for the ADR, foreign ownership, and AFP dummies.

The next section of table 7 includes variables that measure liquidity risk. As discussed above, we expect firms with high liquidity risk to minimize exposure to currency fluctuations. However, the estimated coefficients for the coverage ratio is not significant at conventional confidence levels, and the estimated coefficient of the current ratio is the opposite of what we expect. These results are robust to using alternative liquidity measures (not reported in the table), including the quick ratio, total leverage, short-term debt, and the maturity mismatch. Although the approach we follow here is relatively standard in the corporate finance literature, these puzzling results suggest that our specification suffers from endogeneity issues. Lagging the right-hand-side variable, as we do in this table, only addresses part of the problem. For example, an omitted firm-level variable that is negatively correlated with credit constraints would drive up leverage and at the same time lead to higher dollar exposure, as we find in the table.

Finally, the last part of table 7 shows the results for two variables that proxy for investment opportunities: a lagged moving average of investment over assets and the log of the market-to-book ratio. The sample drops significantly once the market-to-book variable is included because a substantial share of our firms are not listed. We fail to find a statistically significant effect of lagged investment, but the estimated coefficient on the market-to-book ratio is negative and significant, as expected.

6. Exchange Rate Regime, Net Exposures, and the Balance Sheet effect

In this section, we focus on the time dimension of our panel of firms to examine the impact of the adoption of a floating exchange rate regime in the late 1990s on currency mismatches and the size of the balance sheet effect among Chilean firms.

This shift in the policy regime affected the two macroeconomic variables that explain currency mismatches in the mean-variance framework: interest rate differentials and exchange rate volatility. The economywide differentials between domestic and foreign borrowing costs declined, while exchange rate volatility increased. In the period prior to 1998, the annualized standard deviation of monthly depreciations of the dollar-UF exchange rate was 2.4 percent. It doubled to 4.4 percent after the floating of the peso in September 1999 (see table 8).

Accordingly, we expect that the new policy regime created greater incentives for firms to hedge and reduce their currency risk exposures. We further expect the reduction to be sharper in firms that have relatively weak balance sheets and are likely to face capital market imperfections and financial constraints. Both predictions imply that the empirical relevance of the adverse effect of exchange rate depreciations on balance sheets should have declined in Chile after 1999.

6.1 Floating and Currency Risk Exposure in Chilean Firms

In this subsection, we review evidence on the evolution of currency risk exposure across firms in our sample. We begin with a look at different average measures of exposure to foreign exchange risk, and then we reestimate the matching regressions of the previous section to examine changes in the behavior of firms after the shift to the floating exchange rate regime.

Table 8. Average Three-Month Interest Rates and Exchange Rate Volatility[a]

Percent

		US$ (ex ante)				US$ (ex post)				Standard deviation
		EMBI		*LIBOR*		*EMBI*		*LIBOR*		
Period	*UF*	*No URR*	*URR*	*No URR*	*URR*	*No URR*	*URR*	*No URR*	*URR*	*Δ (UF / US$)*
1994–97	8.7	14.5	17.7	5.5	6.7	12.2	14.8	3.4	4.1	2.4
1998–99	9.8	14.8	18.0	5.5	6.7	17.6	21.3	8.0	9.7	2.5
2000–03	5.7	12.7	12.7	3.3	3.3	12.8	12.8	3.4	3.4	4.4
2000–04	5.3	12.0	12.0	3.0	3.0	12.3	12.3	3.2	3.2	4.4

Source: Authors' calculation based on Central Bank data.

a. UF corresponds to the average rate in the financial system on 30- to 89-day loans in CPI-indexed units of account (*Unidad de Fomento*, or UF). EMBI corresponds to the EMBI yield, and LIBOR corresponds to the three-month LIBO rate in U.S. dollars. Ex post U.S. dollar interest rates are calculated as the ex ante U.S. dollar rates adjusted by changes in the UF-US$ exchange rate. Interest rates labeled as URR have been adjusted by the *encaje* (or unremunerated reserve requirement) assuming a two-year loan period. Exchange rate volatility is calculated as the standard deviation of the three–month change in the UF-US$ exchange rate.

All aggregate measures of foreign exchange exposure show a similar pattern (see figure 1): an initial phase of rising currency mismatches from 1995 to 1998, a significant drop through 1999 and 2000, and relative stability in the following two years. Dollar debt increased between 1995 an 1998 from 20 percent of total liabilities to 27 percent, but in the following two years it fell back to 20 percent of total liabilities (18 percent when adjusted for the depreciation of the real exchange rate) and then stayed at that level. Similarly, hedging activity increased sharply during 1998 and 1999 and then stabilized. Firms net (and gross) positions on forward markets ere negligible until 1997, after which the net positions increased sharply, reaching around 4 percent of total liabilities or 10 percent of foreign currency debt.

Similarly, an alternative measure of net accounting exposure in the balance sheet of firms—namely, foreign currency debt adjusted for foreign currency assets and derivatives—increased gradually from 1995 to 1997. It then started to decline, quite sharply in the years 1999 and 2000, until becoming slightly negative in the final years of our sample. Overall, the evolution of aggregate measures of foreign exchange exposition in our sample of firms is consistent with a reduction of exposure after the shift in the macroeconomic policy regime.

The empirical evidence on the differential behavior of firms before and after the changes in the macroeconomic-policy regime is shown in table 9. We reestimate regressions on the hedging behavior of firms, this time including a time dummy for the period prior to the adoption of the floating exchange rate regime and other reforms. Although changes in macroeconomic policies were implemented in 1998 and 1999, we consider that some adjustment costs to the composition of the balance sheet could lead to a lagged response of firms. The dummy variable therefore covers 1995–98, and 1999 is excluded from the sample.

The results for all regressions indicate a significant drop in foreign currency exposure or a significant increase in foreign currency hedging after 1999. The ratio of dollar debt to total assets declines significantly for all firms, to around 20 percent of the pre-float exposure. The dollar debt ratio adjusted for derivatives declines further, to around 35 percent of the pre-float exposure, and the net accounting exposure disappears after 1999. Similarly, the net derivative position increases significantly after 1999. As shown in the graphs for the aggregate numbers, most of the action comes from the reduction of foreign currency debt, with a smaller effect from the increase in derivatives.

Because we have detected an increase in the volatility of the exchange rate in the period after 1999, we expect the drop in the

Figure 1. Exchange Rate Exposure and Derivatives Position in Chilean Firms

Sources: Authors' calculations, based on data from Superintendencia Valores y Seguros (SVS) and International Financial Statistics.

Table 9. Exposure before and after the Float, 1996–2002[a]

	Dollar debt (% total assets)		Dollar debt net of derivative position (% total assets)		Dollar debt net of derivative position and dollar assets (% total assets)		Dollar debt (% total liabilities)		Dollar debt net of derivative position (% total liabilities)		Net derivative position (% total assets)	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Log (total assets)	0.025***	0.048***	0.019***	0.044***	0.008	0.004	0.061***	0.056**	0.050***	0.044*	0.003**	0.000
	(0.004)	(0.012)	(0.004)	(0.012)	(0.006)	(0.018)	(0.008)	(0.024)	(0.008)	(0.026)	(0.001)	(0.006)
Dollar assets /total assets	0.229***	0.133***	0.25***	0.133***			0.522***	0.31***	0.561***	0.304***	−0.045***	−0.012
	(0.057)	(0.028)	(0.056)	(0.029)			(0.071)	(0.056)	(0.069)	(0.059)	(0.014)	(0.013)
Exports/sales	0.117***	−0.017	0.136***	−0.033	0.031	0.138**	0.409***	0.113	0.474***	0.068	−0.031***	0.017
	(0.036)	(0.037)	(0.033)	(0.038)	(0.043)	(0.056)	(0.062)	(0.075)	(0.060)	(0.079)	(0.008)	(0.017)
Dollar debt /total assets											0.105***	0.086***
											(0.036)	(0.016)
Dummy (1996–98)	0.016**	0.019***	0.028***	0.031***	0.038***	0.039***	0.067***	0.064***	0.102***	0.095***	−0.014***	−0.014***
	(0.007)	(0.006)	(0.007)	(0.006)	(0.013)	(0.008)	(0.014)	(0.011)	(0.016)	(0.012)	(0.004)	(0.003)
Summary statistic												
No. observations	923	923	921	921	921	921	923	923	921	921	921	921
R^2	0.28	0.75	0.29	0.72	0.02	0.6	0.41	0.79	0.43	0.77	0.16	0.51
Fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm-clustered standard errors	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Dummy (1996–98) as a percent of pre-float exposure	18	22	33	37	122	125	28	27	44	41		

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. This table reports the estimates of equation 5 in the text. The dependent variable in regressions 1 through 6 is the ratio of exposure to total assets; in regressions 7 through 10 it is the ratio of exposure to total liabilities. The estimation method is OLS. Observations from 1999 are excluded from the regressions. Dummy 1996-98 takes the value of one in the pre-float period. The net derivative position is the notional value of the net long position of foreign exchange derivatives with domestic banks. Standard errors are reported in parentheses.

exposure to be larger for firms with a more vulnerable financial condition. Firms are sampled according to the variables identified in the previous section as measures of a firm's risk aversion. We then test for differences in the change of the foreign exchange exposure after 1999. To measure foreign exchange exposure, we replicate the methodology discussed in the previous section—that is, we estimate the matching portfolio using the dollar assets, exports, and tradable dummies, and we then estimate deviations from this portfolio. To allow for changes across periods in this matching relation, we estimate the first stage allowing for different coefficients across regimes. These coefficients will capture the differences in levels of exposure we discussed above. In the second stage, we interact the firm-level dummies we found to be positively correlated with higher mismatches in the float period with the pre-float dummy. We report these second stage results in table 10. The estimated coefficients on the interactions are negative in all cases except the AFP dummy, although only the interaction with the ADR dummy is significant. This is contrary to what we expect.

Thus far, we have attributed the fall in dollar debt or average exposure to the shift in the macroeconomic policy regime and its impact on compressing interest rate differentials and increasing exchange rate volatility. We have not attempted to disentangle the effects of each of these components. To begin decomposing these two macroeconomic effects, we reestimate our regressions of firm hedging, incorporating the return on the EMBI bond index as a measure of the cost of external finance and the average rate on one- to three-year UF-denominated loans in the Chilean banking system as a measure of the domestic interest rate.[12] We report the results of these estimates in table 11. The estimated signs on the interest rate coefficients are as expected, with dollar debt rising when domestic rates are high and falling with the cost of external financing. As reported in column 2, we also obtain a positive coefficient on the pre-float dummy, even after controlling for the interest rates individually or (as in column 3) by the spread between the two rates.

The interest rate differentials provide an alternative way to validate the a priori measures of credit constraints used in previous sections. One of the predictions of the framework presented above is that interest

12. We carried out these estimations with the LIBO and EMBI rates ex ante, with and without the unremunerated reserve requirement over a two-year entry period; we obtained similar results.

Table 10. Excess Dollar Debt[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Pre-float	0.004	0.063	0.005	0.009**	0.003	0.007	0.003	0.000	0.003	0.007
	(0.005)	(0.049)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Log (assets)	0.016***	0.018***								
	(0.002)	(0.003)								
Pre-float x log (assets)		–0.003								
		(0.003)								
I (ADR)			0.049***	0.081***						
			(0.014)	(0.024)						
Pre-float x I (ADR)				–0.052**						
				(0.022)						
I (foreign)					0.033***	0.043***				
					(0.011)	(0.013)				
Pre-float x I (foreign)						–0.015				
						(0.012)				
I (AFP)							0.025***	0.020**		
							(0.008)	(0.009)		
Pre-float x I (AFP)								0.007		
								(0.009)		
I (GRUPO)									0.022**	0.026**
									(0.010)	(0.012)
Pre-float x I (GRUPO)										–0.006
										(0.009)
Summary statistic										
No. observations	1.221	1.221	1.221	1.221	1.211	1.211	1.221	1.221	1.221	1.221
R^2	0.14	0.14	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The dependent variable is the absolute value of excess dollar debt (net). The estimation method is OLS. I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. Firm-clustered standard errors are reported in parentheses.

Table 11. Macroeconomic Determinants of Net Dollar Debt[a]

	Macroeconomic determinants of net dollar debt			Macroeconomic determinants of net dollar debt *interact*ed firm characteristics				
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Exports / sales	0.043	0.043	0.043	0.017	0.049	0.045	0.048	0.043
	(0.077)	(0.077)	(0.077)	(0.070)	(0.079)	(0.078)	(0.078)	(0.077)
Dollar assets / total assets	0.135***	0.139***	0.139***	0.121***	0.139***	0.139***	0.135***	0.139***
	(0.034)	(0.036)	(0.036)	(0.032)	(0.036)	(0.036)	(0.033)	(0.036)
Domestic interest rate	0.484***	0.218						
	(0.110)	(0.172)						
Foreign interest rate	–0.165**	–0.215***						
	(0.074)	(0.045)						
Spread = (r – r*)			0.216***	0.191***	0.175**	0.078	0.134	0.208
			(0.056)	(0.061)	(0.075)	(0.128)	(0.086)	(0.135)
Dummy(1996–99) = pre-float		0.015***	0.015***	0.022***	0.014***	0.014***	0.016***	0.015***
		(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
log (assets) x spread				0.068*				
				(0.035)				
I (ADR) x spread					0.560			
					(0.722)			
I (AFP) x spread						0.277		
						(0.170)		
I (foreign) x spread							0.303	
							(0.277)	
I (GRUPO) x spread								0.012
								(0.133)
Summary statistic								
No. observations	1.221	1.221	1.221	1.198	1.221	1.221	1.211	1,221
R^2	0.68	0.68	0.68	0.69	0.68	0.68	0.69	0.68

Source: Authors' calculations.

* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.

a. The dependent variable is dollar debt net of the notional derivative value with domestic banks. The estimation is OLS, firm fixed effects, and the main effects of those variables that proxy for risk aversion in the interactions are included but not reported. I (AFP) is a dummy variable for firms eligible to be included in the portfolio of pension fund regulators, I (foreign) is a dummy for firms owned by foreign corporations, I (ADR) is a dummy for firms listing ADRs on the New York Stock Exchange, and I (GRUPO) is a dummy for firms belonging to a conglomerate in 2002 as defined by the SVS. Domestic interest rate is the average three-month rate of return on 30- to 89-day loans in the domestic financial system in UF. The foreign interest rate is the annualized yield on the EMBI bond index. Standard errors adjusted by year clusters are reported in parentheses.

rate differentials have a large effect on currency exposure of firms that are less risk averse. To test this hypothesis, we estimate interactions between the interest rate differential and the measures of a priori credit constraints that we found to be significant in explaining excess net dollar debt (or exposure). In all cases, we obtain positive coefficients (as expected), although these are only significant for the size variable. We thus find some evidence that firms that are less risk averse respond the most to changes in interest rate differentials, as the cost (in terms of financial distress or missed investment opportunities) are lower.

A higher exchange rate volatility in the post-float period is a plausible explanation for the positive coefficient on the pre-float dummy. However, other economywide events occurring in the same period could also be driving our results. An alternative hypothesis to explain why firms closed their currency mismatches after 1998 would be that they faced an external liquidity crunch during this period that pushed them to the local market, independently of the shift in the policy regime and the measured interest rate spread. They had no option but to close the currency mismatches because they could not continue borrowing abroad.

We find no compelling evidence to argue that after 1998, either the Chilean economy was liquidity constrained in international markets or that firms were cut off from international credit. Indeed, in January 1999 the Government was able to fund its fiscal deficit by taping into international markets with spreads of 200 basis points, while risk premiums on private debt had returned to 300 basis points in early 1999. Also, total private foreign debt of nonfinancial firms continued to increase in 1998, 1999, and 2000, from US$21 billion to US$29.4 billion. After 2000, credit spreads continued to decline, although private foreign debt of nonfinancial firms stabilized at US$ 29 billion.

7. Conclusions

This paper contributes to the existing empirical literature on the balance sheet effects of currency mismatches in three ways. First, we assemble a new firm-level database that allows us to build more comprehensive measures of currency exposure. In addition to data on foreign currency debt, our dataset incorporates data on firm-level exports, foreign currency assets, and foreign currency derivative positions. This data should allow us to correct for the omitted variables present in many of the previous studies of balance sheet effects. Second, we explicitly look at differences in exposure across firm-level variables that the corporate finance literature argues (or shows) to be correlated with firm-level risk aversion. Finally, by looking at firm-level data for Chile over the period 1995 to 2003, we are able to identify changes in the level and distribution of dollar debt across two distinct policy regimes. Before 1999, Chile had an exchange rate band and therefore an explicit commitment to exchange rate stability. After 1999, the Central Bank allowed the exchange rate to float freely.

As in previous studies for Chile by Benavente, Johnson, and Morandé (2003) and Fuentes (2003), we find that firms with higher dollar debt do not underperform their peso counterparts in periods following a depreciation. However, once we adequately control for differences in the currency composition of assets and income and in net derivative positions, we find a significant balance sheet effect. In other words, we find that currency mismatches matter when they are correctly measured. We also find that derivatives play a role in insulating firm-level investment from exchange rate shocks and that the balance sheet effects are slightly smaller for firms we categorize a priori as less credit constrained.

In line with previous firm-level studies, we find evidence of currency matching in Chilean corporations. Firms in Chile appear to actively minimize the risks associated with open currency positions and choose the currency composition of their debt and their derivative positions accordingly. They do this by matching the currency composition of their debt with that of their income and assets and by taking on derivatives if no real hedge is available. We also find that exposure—as measured by deviations of dollar-debt net of derivatives from the levels predicted by a simple regression between debt, assets, and exports—is negatively correlated with measures of credit constraints (or firm risk aversion) and investment opportunities. Our results on exposure suggest that the firms that are most exposed to currency risk are better prepared to take this risk.

Finally, we find significant changes in the level of exposure after the exchange rate was floated in 1999. This drop is significant even after we control for a crude measure of interest rate differentials. We argue that one possible interpretation of these results is that the higher exchange rate variance affects the relative risk of domestic and foreign debt. This being the case, the evidence suggests that floating exchange rate regimes would reduce exposure by eliminating an implicit exchange rate insurance and forcing firms to internalize exchange rate risk. More evidence from other emerging market economies is needed to generalize this assertion.

Appendix

Variables Definitions and Sources

Variable	*Definition (codes correspond to the FECU classification)*	*Source*
Main variables		
Investment in fixed capital	k(t) – k(t – 1) / total assets (t – 1)	FECU
Dollar debt over lagged assets	Book value of dollar debt (t) / total assets	Complementary note to FECU
Dollar assets over lagged assets	Book value of dollar assets (t) / total assets	Complementary note to FECU
Net long derivatives position over lagged assets	Nominal value of foreign exchange forward position / total assets	Central Bank of Chile and FECU
Exposure	dd2a – f2a – da2a	
Tradable[a]	1 if ISIC code (rev 2) is 1, 2 or 3	FECU
Exports over total assets	Exports / total assets	PROCHILE and FECU
Exports over sales	Exports / sales	PROCHILE and FECU
Secondary variables		
Total assets	5.10.00.00	FECU
Sales	5.31.11.11	FECU
Capital stock	5.12.10.00 + 5.12.20.00 + 5.12.30.00 + 5.12.40.00	FECU
Leverage (total debt) over total assets	(5.10.00.00 – 5.24.00.00) / total assets	FECU
Cash flow from operations (EBIT)	5.31.11.00 + depreciation	FECU
Cash flow from operations over assets	EBIT / total assets	
Depreciation	5.12.60.00 (t) – 5.12.60.00 (t–1)	FECU
Current ratio = current assets / current liabilities	5.11.00.00 / 5.21.00.00	FECU
Coverage ratio = accrued interest / cash flow from operations	5.31.12.60 / EBIT	FECU

(continued)

Variable	*Definition (codes correspond to the FECU classification)*	*Source*
Market capitalization = PQE	Market cap (December)	Bolsa de Comercio
Accounting equity	5.24.00.00	FECU
Log (market–to–book)	Log (PQE / accounting equity)	FECU and Bolsa de Comercio
Log (Tobin's q)	Log [(PQE + total debt) / total assets]	FECU and Bolsa de Comercio
Maturity mismatch = (current liab – current assets) / total assets	(5.21.00.00– 5.11.00.00) / total assets	FECU
Ownership variables		
ADR	1 if firm has ADR on New York Stock Exchange	J.P. Morgan
GRUPO	1 if firm is in a economic conglomerate	Superintendency of Securities and Insurance (SVS)
AFP	1 if firms is eligible for AFP portfolios	Superindentency of Pension Funds Administrators (SAFP)
Macroeconomic variables		
Log (real exchange rate)	Log (TC_DIC / CPI_DIC)	*International Financial Statistics*
EMBI yield	Annual EMBI return	Bloomberg
Domestic interest rate	Average annualized loan rate in financial system in UF (1 – 3 years)	Central Bank of Chile
CPI_DIC	Consumer price index (December)	*International Financial Statistics*
TC_DIC	Nominal exchange rate (December)	*International Financial Statistics*

There are two companies that we classified as tradable that do not follow this definition: LAN Chile (the privatized national airline) and Cia. Sudamericana de Vapores (the shipping company).

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Is the Foreign Exchange Derivatives Market Effective and Efficient in Reducing Currency Risk?

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Floating foreign exchange rates have gained increased support as a preferred system for reducing the vulnerability of emerging markets to external shocks. The volatility associated with floating exchange rates, however, exposes economic agents to the risk of changes in the valuation of the financial assets and liabilities in their balance sheet, as well as in their stream of current and expected cash flows. Since derivatives provide agents with tools to insure against risk, the development of the foreign exchange derivatives markets would appear to be a key complement to a successful floating exchange rate system.

A foreign exchange derivatives market, however, may not be effective in diminishing an economy's aggregate vulnerability to exchange rate fluctuations. Foreign exchange derivatives reduce the adjustment cost of foreign exchange positions both for participants in the market who want to hedge their initial positions and for those who want to increase their exposure to foreign exchange risk. They can also help amplify the effects of agents' decisions on the foreign exchange rate, which can be either stabilizing or destabilizing. In the aggregate, the net effect of foreign exchange derivatives could well be to increase the volatility of the exchange rate and/or the overall exposure of economic agents to

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exchange rate fluctuations. The end result could be more, rather than less, overall vulnerability to foreign currency risk.

In addition, even if a foreign exchange derivatives market effectively contributes to reducing currency risk, the efficiency with which it operates may be unsatisfactory. Two aspects of particular concern are market transparency and competition. No participants should systematically have superior information about exchange rate movements that would enable them to take more profitable positions when they foresee a convenient movement in the foreign currency, or have sufficient market power that their actions generate significant changes in the exchange rate. In short, there should be no asymmetric information among traders that may be price relevant.

The issue of whether foreign exchange derivatives are effective and efficient in reducing currency risk is particularly relevant in the case of emerging market economies. Potential problems in foreign exchange derivatives markets are likely to be accentuated in these economies, given their relatively thinner, less liquid, and less developed financial markets. Consequently, agents in these countries are debating the merits of foreign exchange derivatives as a mechanism for reducing currency risk, in particular in light of concerns stemming from the fairly recent adoption of floating exchange rate regimes.

Empirical evidence on whether and how the foreign exchange derivatives market reduces vulnerability to foreign exchange rate fluctuations is scant. While a few studies address the effects of derivatives on the volatility of other financial prices, we are not aware of previous attempts to empirically assess the effects of foreign exchange derivatives on foreign exchange rate volatility, for either advanced or emerging market economies. Allayannis and Ofek (2001) and Cowan, Hansen, and Herrera (in this volume), among others, suggest that foreign exchange derivatives tend to reduce currency exposure, but these valuable studies are conducted only at the firm level. Works such as Wei and Kim (1997) and Klitgaard and Weir (2004) take on the issue of whether traders in foreign exchange derivatives markets possess price-relevant asymmetric information, based on weekly data for U.S. markets. However, no studies to date use daily or intradaily data or extend the analysis to emerging market economies.

This paper provides some empirical evidence to shed light on the issue of whether foreign exchange derivatives markets effectively and efficiently reduce currency risk. Although it presents some cross-country data, the core of the analysis focuses on the data for the Chilean economy. Among emerging market economies, Chile offers a particularly interesting case. The country adopted a floating exchange rate in September 1999, after a decade of enforcing an exchange rate band whose width and level were often revised. The new floating exchange rate regime is widely perceived as successful. In addition, while its foreign exchange derivatives market has grown into a reasonably active market given the size of the economy, the degree of market development is still far from the level in advanced economies, and the market's usefulness as a mechanism for reducing agents' currency risk has often been called into question. Last, but not least, we were able to access a unique daily and intradaily database on the purchases and sales of most market participants.

The remainder of this paper is organized as follows. Section 1 of this paper presents the main recent tendencies and characteristics of the Chilean foreign exchange derivatives market. Sections 2 and 3 use cross-country analysis and time-series data for Chile to explore the contribution of foreign exchange derivatives to the effective reduction of currency risk, examining their relation with foreign exchange volatility and foreign exchange exposures, respectively. Section 4 explores the efficiency of the Chilean foreign exchange derivatives market, looking for evidence of asymmetric information that is price relevant. Section 5 provides concluding remarks.

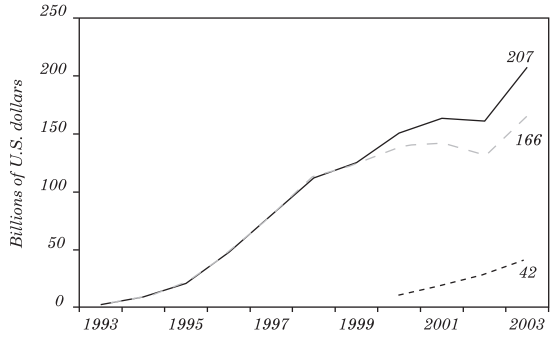
1. Characteristics of the Derivatives Market in Chile

In this section we briefly describe and analyze the main trends and characteristics of the Chilean foreign exchange derivatives market. Foreign exchange forwards were around 75 percent of total foreign exchange derivatives turnover in 2003; the remainder is explained mainly by foreign exchange swaps and cross-currency swaps. Earlier studies by Caballero, Cowan, and Kearns (2004), Fernández (2001), and Velasco and Arellano (2003) also analyze the Chilean foreign exchange derivatives market, although with a focus different than ours. We use a unique dataset of foreign exchange derivatives compiled at the Central Bank of Chile, which covers all operations involving a domestic bank or a nonresident counterparty.[1] Alarcón, Selaive, and Villena (2004) provide some additional statistics and international comparisons.

Figure 1 presents Chile's foreign exchange derivatives turnover from 1993 to 2003, broken down into domestic and cross-border subscriptions. Turnover grew rapidly and persistently in this period, a trend that is consistent with the increased flexibility of the exchange rate and a deepening of the Chilean economy's trade and financial integration with the rest of the world (Jadresic and others, 2003).

1. Interbank trading is considered only once. Numbers do not include offshore operations.

Figure 1. FX Derivatives Turnover[a]



Source: Authors' calculations based on data from the Central Bank of Chile.
a. Amounts correspond to total turnover—purchases and sales—of currency derivatives.

From the perspective of banking sector operations, the nonfinancial and institutional sector increased its share in total turnover from 12 percent in 1998 to 23 percent in 2003 (see table 1).[2] This development is explained mainly by the internationalization of the pension funds (AFPs). In cross-border operations, the nonbank financial sector captured 65 percent of total turnover (see table 2). Thus, a large part of cross-border forward foreign exchange operations is not directly carried out by commercial banks.[3]

Table 1. Turnover of the Domestic Banking Sector by Domestic Counterparty
Billions of U.S. dollars

Year	*Nonfinancial and institutional sectors*	*Interbank*	*Nonbank financial sector*	*Total*
1998	13.259	35.647	63.244	112.150
1999	21.412	45.218	58.864	125.494
2000	21.536	51.840	65.852	139.228
2001	29.864	49.928	63.399	143.192
2002	25.538	42.403	62.745	130.686
2003	38.188	62.662	64.985	165.835

Source: Authors' calculations based on data from the Central Bank of Chile.

2. The institutional sector includes pension funds, mutual funds, and insurance companies.
3. The number of counterparts in each sector is presented in Alarcón, Selaive, and Villena (2004).

Table 2. Turnover of the Foreign Market by Domestic Counterparty
Billions of U.S. dollars

Year	*Nonfinancial and institutional sectors*	*Domestic banks*	*Nonbank financial sector*	*Total*
1998	—	—	—	—
1999	—	—	0.020	0.020
2000	0.503	1.300	9.843	11.646
2001	0.255	6.218	13.835	20.308
2002	0.132	9.681	20.602	30.414
2003	0.352	14.091	27.148	41.592

Source: Authors' calculations based on data from the Central Bank of Chile.

The average size of forward operations was around US$4.5 million in 2003, and cross-border contracts were much larger than the onshore contracts (see table 3). Of the cross-border contracts, the largest were taken out by the nonbank financial sector. The nonfinancial and institutional sectors have experienced a steady decrease in the size of contracts, which is explained by a larger number of counterparties in the former sector.

Table 4 shows the maturity breakdown for onshore and cross-border forward operations. In 2003, 2.6 percent of total turnover was associated with contracts of over one year, which is quite close to the world average of 3 percent. Also, the share in contracts of less than seven days has decreased.

In table 5 we present activity indicators constructed from data of the triennial survey of the Bank for International Settlements (BIS). The ratios of derivatives over GDP and over trade flows locate Chile below but close to the average of emerging market economies, although quite far from advanced economies.

Table 6 displays the average level and volatility of spreads for Chile and other selected economies, constructed from daily data available at Bloomberg for years 1998 and 2003.[4] Chile's spread shows a persistent decrease over this period, with a level and volatility in the range of those observed in Australia, Brazil, Mexico, and New Zealand. Table 7 then shows the correlation of daily spreads between January 1998 and December 2003 for the same economies. The cross-correlation among countries is remarkably low (the simple average of all pairwise correlations yields 0.04). Chile's spread moves together somewhat with Brazil's, but comovement with the other selected economies is not significant.

4. Bloomberg reports spreads for a sample of reporting dealers who carried out cross-border and local operations.

Table 3. Median Size of Operations: Domestic and Cross-Border Market
Millions of U.S. dollars

	Domestic banking				*Cross-border operations*				
Year	*Nonfinancial and institucional sectors*	*Interbank*	*Nonbank financial sector*	*Total*	*Nonfinancial and institucional sectors*	*Banks*	*Nonbank financial sector*	*Total*	*Total*
1998	3.8	2.0	7.4	3.7	—	—	—	—	3.7
1999	4.6	2.5	7.3	4.0	—	—	1.6	1.6	4.0
2000	3.7	2.8	6.9	4.1	19.3	11.4	4.8	5.3	4.2
2001	2.9	4.2	10.1	5.1	8.5	6.9	5.7	6.1	5.2
2002	2.0	5.3	9.5	4.6	3.0	5.8	5.1	5.3	4.7
2003	1.8	5.5	10.8	4.3	1.8	6.5	5.3	5.6	4.5

Source: Authors' calculations based on data from the Central Bank of Chile.

Table 4. Maturity Breakdown[a]

Percent

	Share in total turnover		
Year	*Up to 7 days*	*8 days to 1 year*	*Over 1 year*
1998	36.6	62.5	0.9
1999	23.4	75.1	1.6
2000	18.0	79.9	2.1
2001	20.9	75.8	3.3
2002	19.9	77.4	2.7
2003	15.5	82.0	2.6
World average, 2001	33.5	63.5	3.0

Source: Authors' calculations based on BIS (2002).
a. Includes local and cross-border operations in pesos and *Unidades de Fomento* (UF).

Table 5. Activity Indicators

	D / GDP		*D / (X + M)*	
Country	*1998*	*2001*	*1998*	*2001*
Argentina	0	0	1	0
Australia	19	27	60	80
Austria	8	5	12	7
Bahrain	37	48	24	39
Belgium	20	8	30	5
Brazil[a]	3	4	22	19
Canada	11	12	16	17
Chile	2	2	4	5
Colombia	—	0	—	1
Czech Republic	13	5	14	4
Denmark	31	30	57	50
Finland	6	2	11	4
France	10	8	23	16
Germany	7	9	14	15
Greece	8	6	25	20
Hong Kong	74	75	34	31
Hungary	2	1	3	1
India	1	1	4	4
Indonesia	3	1	3	1
Ireland	16	11	11	9
Israel	—	1	—	2
Italy	4	3	9	6
Japan	6	7	33	38
Korea, Rep	12		1	3
Luxembourg	198	119	183	108

Table 5. (continued)

	D / GDP		*D / (X + M)*	
Country	*1998*	*2001*	*1998*	*2001*
Malaysia	3	3	2	1
Mexico	1	2	2	3
Netherlands	17	16	17	14
New Zealand	23	15	51	28
Norway	10	14	19	26
Peru[a]	0	0	0	1
Philippines	2	2	2	2
Poland	1	5	2	10
Portugal	6	2	10	3
Russia	1	0	2	0
Saudi Arabia	2	1	3	2
Singapore	261	202	103	72
Slovak Republic	—	6	—	5
Slovenia	—	0	—	0
South Africa	10	17	23	35
Spain	6	2	25	5
Sweden	12	23	18	34
Switzerland	55	53	90	79
Thailand	5	3	6	3
Turkey	—	1	—	2
United Kingdom	82	68	197	160
United States	7	4	36	22
World average	23	18	29	21
Advance economies[b]	17	16	38	32
Emerging economies[b]	4	4	6	6

Source: Authors' calculations based on data from BIS (1999, 2002), and IMF, *International Financial Statistics* (various issues).
— Insufficient data.
a. Turnover for Brazil and Peru were obtained from their respective central banks.
b. Emerging economies exclude Hong Kong and Singapore. See appendix for the classification of the economies.

In 2003, nine banks accounted for approximately 80 percent of derivatives turnover. Figure 2 plots the Herfindahl-Hirschman index (HHI) for both spot and derivatives contracts intermediated by banks. The index stands close to, but below, 1,000 points, indicating a low degree of concentration according to the usual standards.[5]

5. Markets in which the index is between 1,000 and 1,800 points are considered to be moderately concentrated, and those in which the HHI is in excess of 1,800 points are considered to be concentrated. (See the U.S. Department of Justice and the Federal Trade Commission, *Horizontal Merger Guidelines,* section 1.5.1, 1997.

Table 6. Level and Volatility of Spreads
Percent

Country	Quoted forward spreads, 30 days 1998	1999	2000	2001	2002	2003	Forward spread volatility[a]	Period
Australia	0.09	0.08	0.09	0.10	0.09	0.07	0.07	1998–2003
Brazil	—	0.45	0.40	0.19	0.20	0.16	0.26	Oct. 1999–2003
Chile	0.21	0.23	0.13	0.10	0.10	0.11	0.13	April 1998–2003
New Zealand	0.13	0.13	0.15	0.15	0.15	0.12	0.07	1998–2003
Mexico	0.21	0.15	0.13	0.11	0.10	0.11	0.18	1998–2003

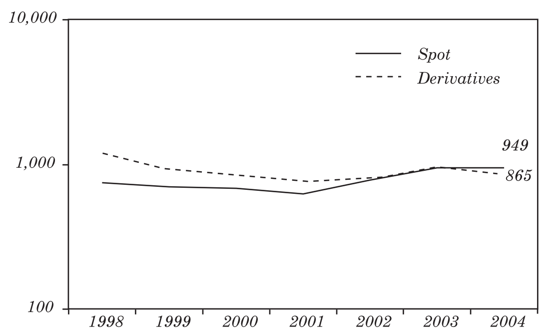
Source: Authors´ calculations based on data from Bloomberg.
a. Volatility measured by the standard deviation of the spread first difference.

Table 7. Correlation of Daily Forward Spreads, Thirty Days[a]

Country	Country: Australia	Brazil	Chile	New Zealand	Mexico
Australia	1.00	0.06	–0.08	0.20	0.05
Brazil	—	1.00	0.15	0.00	0.09
Chile	—	—	1.00	–0.05	0.01
New Zealand	—	—	—	1.00	–0.05

Source: Authors' calculations, based on data from Bloomberg.
a. Spreads based on bid-ask quotes for the period 1 January 1998 to 31 December 2003.

Figure 2. HHI Index for Turnover Intermediated by Banks[a]



Source: Authors' calculations, based on data from the Central Bank of Chile.
a. Based on banks' market shares in total turnover. *Y* axis in logarithmic scale.

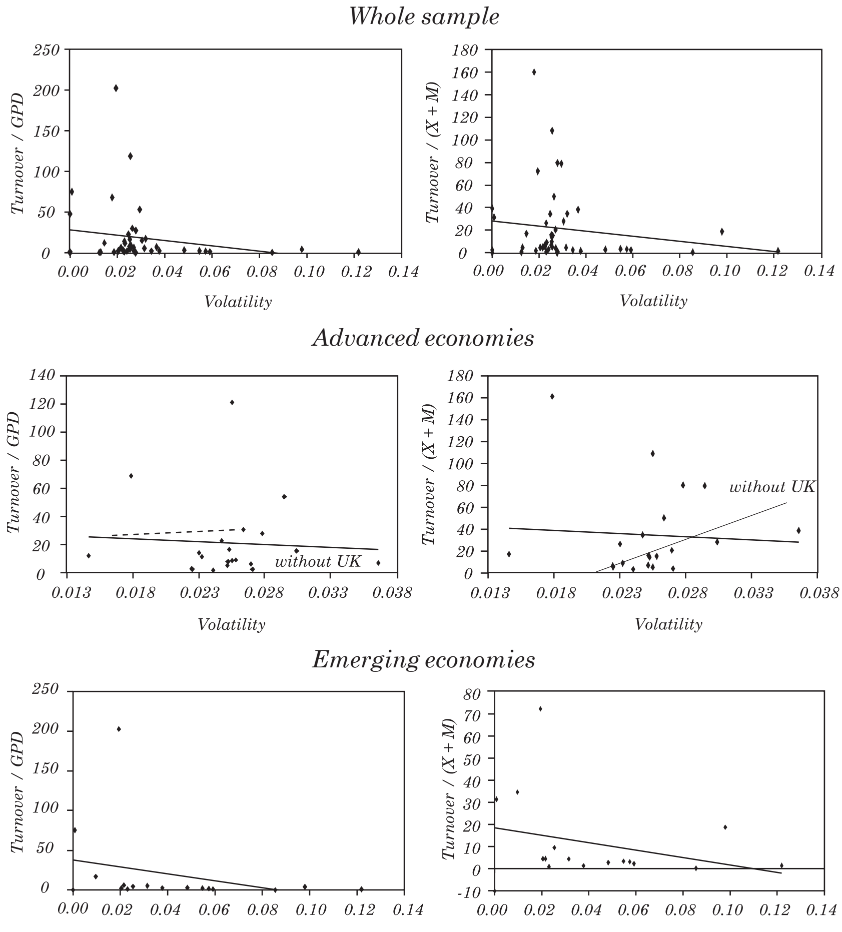
2. The Foreign Exchange Derivatives Market and the Volatility of the Spot Exchange Rate

Previous research has been oriented to analyzing the relation between volatility and activity mainly in stock markets. Models predict different relations between price and volume that depend on the rate of information flow to the market, how the information is disseminated, the extent to which market prices convey information, and the size of the market. Price variability affects the volume of trade in forwards. The time to delivery of a forward or futures contract affects the volume of trading and, through this effect, possibly also the variability of prices. The price-volume relation can also indicate the importance of private versus public information in determining investors' demands (Karpoff, 1987).

Cornell (1981) associates volatility with uncertainty, arguing that volatility may lead to an increase in both hedging and speculative trading in derivatives contracts. Uncertainty may lead risk-averse agents to transfer risk to those better able to bear it. Uncertainty is also supposed to lead to asymmetric information, so greater uncertainty provides a speculative motive for trading. Among the links between volatility of price and activity, hedging creates a positive relation, while speculative transactions create a link between price variability and volume that ultimately depends on the public (or private) nature of the information. Stein (1987) develops a model in which prices are determined by the interaction between hedgers and informed speculators. In this model, the derivatives market improves risk sharing and therefore reduces price volatility. Moreover, if speculators observe a noisy but informative signal, hedgers react to the noise in the speculative trades, producing an increase in volatility. In contrast, Danthine (1978) argues that futures markets improve market depth and reduce volatility because they reduce the cost to informed traders of responding to mispricing. Models developed by Kyle (1985), Ross (1989), and Froot and Perold (1990), among many others, associate asset volatility with the rate of information flow. Their models imply that the volatility of the asset price will increase as the rate of information flow increases. Thus, if forward operations increase the flow of information, the volatility of the spot price must change accordingly.

While all these motives may seem intuitively appealing, the precise interaction can only be established empirically. We therefore build on the above literature by making a simple cross-country association between volatility and development of the derivatives market based on data from BIS (2002) (see figure 3). Although the number of observations is not enough to establish a convincing stylized fact, there seems to be

Figure 3. Derivatives Usage and Exchange Rate Volatility, 2001



Source: Authors' calculations, based on data from BIS (2002) and IMF's *International Financial Statistics*.
a. Volatility constructed as the standard deviation of the change in the monthly (log) exchange rate for the period 1994–99. Turnover corresponds to subscriptions of forwards, foreign exchange swaps, options, and futures.

a negative association between exchange rate volatility and derivatives. The negative association persists when we split the sample between advanced and emerging economies, although it weakens for the former group because of the inclusion of United Kingdom.[6] We explore this finding further in the next subsection.

6. See the appendix for our classification of the economies.

2.1 Volatility and Derivatives: A Cross-country Approach

We explore the following empirical specification for exchange rate volatility across countries:

$$\mathrm{VOL}_i = \beta_0 + \beta_1 \mathrm{OPEN}_i + \beta_2 \mathrm{FIN\_DEV}_i + \beta_3 \mathrm{SIZE}_i + \beta_4 \mathrm{GDP\_PC}_i + \beta_5 \mathrm{DERIV}_i + \mu_i,$$

where VOL_i is the level of nominal exchange rate volatility constructed using monthly data over 1994:1 to 1999:4, drawn from the IMF's *International Financial Statistics*. OPEN is the ratio of the sum of exports and imports over GDP.[7] The benefit of a floating nominal exchange rate is inversely related to the level of trade with the rest of the world.[8] SIZE is the log of the average real GDP adjusted by purchasing power parity (PPP) of years 1999 to 2001, obtained from the World Bank's *World Development Indicators*. This variable serves as a proxy for the microeconomics benefits of exchange rate stability: smaller countries should be less tolerant of fluctuations in the nominal exchange rate than larger countries. FIN_DEV is measured as the ratio of private lending to GDP in 2001. As with size, more financially sophisticated countries should be able to tolerate a higher level of exchange rate volatility less sophisticated ones. The sign may also be negative, however, if domestic financial development helps to stabilize the exchange rate. Finally, DERIV corresponds to currency derivatives reported in BIS (2002) over current GDP.

We include GDP_PC (that is, per capita GDP, in PPP units) as an extra control variable, following Devereux and Lane (2002). This provides a general check for potential omitted variable bias, and the expected sign is negative: richer countries should have more stable exchange rates than poorer countries.

Table 8 presents a cross-country estimation. For the full sample of countries, (the first two columns), standard variables work reasonably well. Only OPEN does not have the expected sign, although the parameters are not significant either. The simple pairwise correlation between openness and volatility is –0.07, which indicates that a time series analysis may yield the expected negative sign.[9]

7. The list of countries is available upon request.

8. Devereux and Lane (2002) and Hau (2002), among others, find empirical evidence of a negative relation between volatility and openness.

9. In our case, a time series analysis is restricted by the unavailability of derivatives statistics.

Table 8. Volatility Regression: OLS Estimation[a]

	Full sample		Non-OECD countries	
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Openness	0.003 (0.004)	0.007 (0.004)	0.003 (0.005)	0.009 (0.007)
Financial development	–0.011*** (0.003)	–0.007*** (0.003)	–0.010*** (0.003)	–0.009** (0.004)
Size	0.003*** (0.001)	0.004*** (0.001)	0.004** (0.001)	0.005*** (0.001)
GDP per capita		–0.004* (0.002)		–0.005* (0.003)
Derivatives usage	–0.011 (0.001)	–0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)
Summary statistic				
R^2	0.11	0.13	0.10	0.13
No. observations	124	124	102	102

Source: Authors' calculations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is STDEV[d(log(NER$_i$)]. Standard errors and covariance are White heteroskedasticity consistent. Standard errors are in parentheses.

For the full sample and also for non-OECD countries, FIN_DEV enters with a significantly negative coefficient. This suggests that domestic financial development helps to stabilize exchange rate movements, for instance by facilitating intertemporal smoothing by households and firms or adding liquidity to financial markets (Devereux and Lane, 2002). Finally, DERIV is consistently negative, but not significant for all cross-sectional estimates.

The ordinary least squares (OLS) results may not be fully reliable if some of the regressors are endogenously determined by exchange rate volatility. We consider three variables to be potentially affected by this problem: OPEN, FIN_DEV, and DERIV. Exploring an instrumental variables (IV) estimation procedure may not be appealing, however, for two reasons: finding good instruments would not be easy, especially for DERIV; and evidence on bilateral exchange rate volatility presented in Devereux and Lane (2002) suggests that the IV procedure may not change the results substantially.

These results are tentative in that they do not account for endogeneity of the right-hand-side variables. Nevertheless, they suggest that exchange rate volatility may be better explained by expanding the standard variables to include other financial determinants. After controlling for macroeconomic determinants, we find that a more developed derivatives market does not increase exchange rate volatility. Finally, further extensions incorporating other financial linkages across countries, in particular currency-hedging variables, hold promise for improving the assessment of the robustness of our findings.

2.2 Volatility and Derivatives: Daily Approaches for Chile

An alternative approach for gauging the relation between foreign exchange derivatives and exchange rate volatility is to examine the behavior of high-frequency time series on market turnover, open positions, and volatility. A number of recent empirical studies examine the effects of index futures on the volatility of the underlying index. Some of them strongly support the view that index futures do not increase the long-run volatility of the spot price (Yu, 2001). They also conclude that stock market volatility is not related to either the existence or the level of activity in the futures market. Other studies, however, reach the opposite conclusion, claiming that futures increase the volatility of the spot price (see Brorsen, 1991, among others).

Empirical research thus far has not produced any conclusive evidence on the general impact of futures trading on spot market volatility. Therefore, it is of particular interest to examine the case of the foreign exchange markets. References on this subject are nonexistent, so we follow approaches regularly applied in the analysis of stock markets.

First, we estimate an exponential generalized autoregressive conditional heteroskedasticity model, or EGARCH(1,1)-M, augmented by activity measures closely following Bessembinder and Seguin (1992).[10] We use two activity measures: turnover, which corresponds to the volume of purchases and sales in all foreign exchange derivatives, and notional outstanding amounts, which correspond to the notional values of all deals concluded but not yet settled on a given date.[11] We calculate

10. Morandé and Tapia (2002) also use a GARCH-M model for the Chilean exchange rate. The ARCH-M models are often used in financial applications when the expected return on an asset is related to the expected asset risk. We therefore introduce the conditional "variance" in the conditional mean equation. The EGARCH model implies that the leverage effect is exponential and that forecasts of the conditional variance are guaranteed to be nonnegative.

11. Outstanding positions are not available on a cross-country basis.

volatility based on a real exchange rate obtained by deflating the nominal rate by daily inflation.[12] The sample period covers from 1 January 1995 to 30 June 2004.[13] The daily and intraday approaches are the most commonly used, since it is difficult to find reasonable justifications for a weekly or monthly association between volatility and activity. Nevertheless, uncovering the relationship between these two markets may depend on the time frame used for analysis.

We report the results in table 9 (specification A). For the full sample period, we do not observe a significant link between activity and volatility for the forward and spot market variables tested (see columns 1 through 6 in the table). We observe the same pattern for the period after the exchange rate band, with all coefficients negative and insignificant.

To further test the reliability of the results, we perform an instrumental variable estimation in which we employ the conditional volatility obtained from a GARCH model.[14] The results are in table 10. Under this approach we observe a weak negative link between volatility and activity in the derivatives market for the crawling band period (columns 1 and 2). Similarly, we observe a positive link between activity in the spot foreign exchange market and volatility.[15] No link emerges, however, during the free-floating period for any of the variables tested.

Our last exercise works with a measure of volatility based on intraday prices, and we focus our attention on the free-floating period. Figure 4 presents the nominal exchange rate level and a measure of intraday variability constructed with all interbank transactions, excluding derivatives contracts expiring within a given day. Our proxy of variability is the intraday standard deviation over the daily weighted average nominal exchange rate.[16] This simple graphical representation suggests that nominal exchange rate volatility increased after the elimination of the crawling band.

12. We also performed all estimations using the nominal exchange rate, and the results were unaltered.

13. Implied volatility derived from at-the-money options traded offshore may be an alternative measure of volatility. The advantage of this option-based approach over GARCH is that it uses current market-determined prices that reflect the market's true volatility forecast, rather than a series model based on an assumed relation between future volatility and past exchange rate movements.

14. We performed estimations using different ARCH models, and the results were uniformly unaltered. Jeanneau and Micu (2003) perform a similar IV estimation with monthly data.

15. Bessembinder and Seguin (1992) also find a positive association between spot volume and volatility.

16. The calculations implied working with approximately 780,000 operations. We also used the difference between the day's maximum and minimum prices, and the results were unaltered.

Table 9. Volatility–Activity Relation: Specification A[a]

Period and coefficient for activity	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Full period						
Turnover derivatives	0.067		0.039	0.082		0.057
	(0.050)		(0.059)	(0.050)		(0.059)
Outstanding		0.280	0.241		0.291	0.249
		(0.230)	(0.275)		(0.235)	(0.277)
Turnover spot				–0.035	–0.017	0.045
				(0.112)	(0.100)	(0.101)
No. observations	2366	2366	2366	2366	2366	2366
Crawling band						
Turnover derivatives	0.161**		0.142	0.111		0.105
	(0.073)		(0.109)	(0.091)		(0.125)
Outstanding		0.331	0.178		0.164	0.081
		(0.327)	(0.466)		(0.286)	(0.412)
Turnover spot				0.216	0.251**	0.205
				(0.174)	(0.127)	(0.156)
No. observations	1164	1164	1164	1164	1164	1164
Free float						
Turnover derivatives	–0.045		–0.044	0.021		0.022
	(0.059)		(0.069)	(0.073)		(0.072
Outstanding		–0.076	–0.007		0.016	–0.007
		(0.167)	(0.195)		(0.195)	(0.190)
Turnover spot				–0.129	–0.117	–0.129
				(0.108)	(0.098)	(0.108)
No. observations	1201	1201	1201	1201	1201	1201

Source: Authors' calculations.

** Statistically significant at the 5 percent level.

a. The specification method is EGARCH-M augmented by activity measures. Following Bessembinder and Seguin (1992), we first detrended the activity series using by the Hodrick-Prescott algorithm setting $l = (250^2) \times 100$.Robust t statistics were calculated using the Bollerslev and Woolrigde procedure. The three periods are defined as follows: full period: January 1995 to June 2004; crawling band: January 1995 to September 1999; free float: September 1999 to June 2004. Standard errors in parentheses.

Table 10. Volatility–Activity Relation: Specification B[a]

Period and coefficient of volatility	*(1)*	*(2)*	*(3)*
Full period			
Turnover Derivatives	–1428***		
	(427)		
Outstanding		–31.0***	
		(11.49)	
Turnover Spot			632.7***
			(243.3)
Adjusted R^2	0.70	0.99	0.59
No. observations	2366	2366	2366
Crawling band			
Turnover Derivatives	–695.6		
	(670.2)		
Outstanding		–50.1***	
		(18.8)	
Turnover Spot			964.4***
			(283.9)
No. observations	1164	1164	1164
Adjusted R^2	0.65	0.99	0.29
Free float			
Turnover Derivatives	–27.1		
	(484.6)		
Outstanding		–22.9	
		(15.9)	
Turnover Spot			472.4
			(311.3)
Adjusted R^2	0.28	0.99	0.44
No. observations	1201	1201	1201

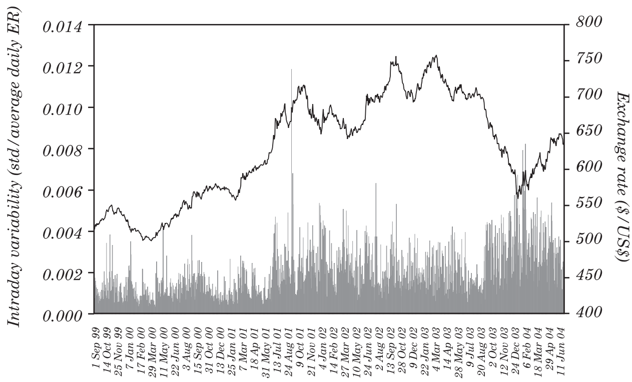
Source: Authors' calculations.

*** Statistically significant at the 1 percent level.

a. $\text{Activity}_t = \text{a} + \text{bActivity}_{t-1} + \text{gVolatility}_t + \text{dTrend} + e_t$. Volatility was first estimated from a GARCH(1,1) model. Robust t statistics were calculated using the Bollerslev and Woolrigde procedure. Standard errors and covariance are Newey-West heteroskedasticity and autocorrelation consistent (HAC). The three periods are defined as follows: full period: January 1995 to June 2004; crawling band: January 1995 to September 1999; free float: September 1999 to June 2004. Standard errors in parentheses.

We restrict our activity variables to outstanding positions held by large participants in the derivatives market. Such disaggregated information provides an opportunity to investigate the impact on volatility of individual trader groups. We first present the Pearson correlation coefficients between our intraday volatility measure and the contemporaneous and lagged temporary component of outstanding positions held by each participant. We extract temporary components by the standard Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1980) (see table 11). The table shows that temporary changes in activity associated with the unexpected component of the series have a weak positive relation with the intraday volatility

Figure 4. Intraday Variability, September 1999 to June 2004



Source: Authors' calculations, based on data from the Central Bank of Chile.

Table 11. Cross-Correlation Coefficients: Volatility Measure versus Temporary Component of Outstanding Position Series

Outstanding position series[a]	*Correlation*	*Causality*[b]
Banks with foreign clients		
Temporary_t	0.000	no
Temporary_{t-1}	0.052	no
Nonbank domestic agents with foreign clients		
Temporary_t	–0.049	no
Temporary_{t-1}	–0.129	no
Banks with pension funds		
Temporary_t	0.160	yes
Temporary_{t-1}	0.211	yes
Banks with the nonbank financial sector		
Temporary_t	–0.004	no
Temporary_{t-1}	–0.004	no
Banks with the nonfinancial sector		
Temporary_t	0.097	no
Temporary_{t-1}	0.016	no
Banks with other domestic agents		
Temporary_t	0.096	no
Temporary_{t-1}	0.068	no

Source: Authors' calculations.

a. Series filtered by the Hodrick-Prescott filter setting l = (250^2) x 100.

b. Granger causality test for thirty-six lags and 5 percent probability. Volatility never caused temporary outstanding series.

of the nominal exchange rate. In fact, the trading volumes of the nonbank financial sector and nonbank domestic agents with foreign clients are negatively related to volatility.

We also perform a bivariate autoregression to test for granger-causality between volatility and temporary activity in the derivatives market (Lee and Rui, 2002). Granger causality tests indicate that series do not cause volatility, with the exception of temporary activity of pension funds.

Finally, among the many alternatives, we chose to evaluate the contemporaneous relation between trading volumes and volatility, estimating the following two simultaneous equation model:

$$\mathrm{VOL}_t = \alpha_0 + \alpha_1 \mathrm{TEMP}_t^i + \alpha_2 \mathrm{VOL}_{t-1} + \varepsilon_t \quad \text{and} \tag{1}$$

$$\mathrm{TEMP}_t^i = \alpha_0 + \alpha_1 \mathrm{VOL}_t + \alpha_2 \mathrm{TEMP}_{t-1}^i + \check{i}_t , \tag{2}$$

where TEMP^i corresponds to the temporary component of the outstanding position of participant i, and VOL corresponds to the intraday variability measure presented in figure 4. To avoid problems of simultaneous bias, we estimate the system in equations 1 and 2 using the generalized method of moments (GMM) and a three-stage least squares (3SLS) procedure.

Our results are in table 12. Remarkably, none of the outstanding position series has a significant link with the intraday volatility measure during the free-floating period. These results suggest that the link between nominal exchange rate volatility and activity in the derivatives market has been quite weak or nonexistent in the free-floating period.

3. The Role of the Foreign Exchange Derivatives Market in Reducing Exposure to Foreign Exchange Fluctuations

The notional value of the net outstanding foreign exchange forward positions indicates that Chilean residents have, in recent years, been in a net short position with respect to nonresidents. This reflects the fact that foreign investors' hedging of their direct and portfolio investments in the local market and resident firms' hedging of their external liabilities has more than surpassed the hedging positions taken by domestic agents that invest abroad (namely, pension funds, mutual funds, and the nonfinancial sector). The net

Table 12. Contemporaneous Relation between Volume and Volatility: Temporary Component of Outstanding Position Series[a]

	Estimation method			
	GMM		*3SLS*	
Trading relation	α_1	β_1	α_1	β_1
Banks with foreign clients	$-2.3\text{x}10^{-7}$ $(2.2\text{x}10^{-7})$	3813.4 (3879.9)	$-2.2\text{x}10^{-7}$ $(2.5\text{x}10^{-7})$	2958.5 (3800.9)
Nonbank domestic agents with foreign clients	$-9.8\text{x}10^{-8}$ $(1.2\text{x}10^{-7})$	–3225.1 (7942.9)	$-9.5\text{x}10^{-8}$ $(1.3\text{x}10^{-7})$	–2490.7 (7774.9)
Banks with pension funds	$2.5\text{x}10^{-7}$ $(2.5\text{x}10^{-7})$	510.79 (2683.66)	$2.8\text{x}10^{-7}$ $(1.9\text{x}10^{-7})$	404.84 (2266.73)
Banks with the nonbank financial sector	$3.5\text{x}10^{-9}$ $(6.9\text{x}10^{-8})$	–2788.7 (9557.4)	$1.6\text{x}10^{-9}$ $(7.0\text{x}10^{-8})$	–6510.2 (9137.9)
Banks with the nonfinancial sector	$1.4\text{x}10^{-8}$ $(1.4\text{x}10^{-7})$	5951.9 (3901.8)	$2.3\text{x}10^{-8}$ $(1.3\text{x}10^{-7})$	5349.3 (4160.1)
Banks with other domestic agents	$3.5\text{x}10^{-8}$ $(7.4\text{x}10^{-8})$	7822.9 (10164.0)	$3.7\text{x}10^{-8}$ $(6.7\text{x}10^{-8})$	7822.9 (10164.0)

Source: Authors' calculations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. Daily observations from September 1999 to June 2004. White Heteroskedasticity-Consistent Standard Errors & Covariance. Instruments are lags of endogenous variables. Standard errors and covariance are White heteroskedasticity consistent. Standard errors are in parentheses.

short position has also been quite small as a percentage of the GDP (–1% in 2002 and –2% in 2003). It thus seems unlikely that the Chilean foreign exchange derivatives market is currently substantially modifying the overall gap between assets and liabilities denominated in foreign currency.[17]

Given that Chile's foreign exchange derivatives market is less developed than those of advanced economies, we explore whether economies with more developed foreign exchange derivatives markets present more or less aggregate exposure to currency risk. A common measure of aggregate currency mismatches is net foreign debt (see Caballero, Cowan, and Kearns, 2004; Goldstein and Turner, 2004).[18] Table 13 presents this measure for a group of selected economies. The measure does not incorporate the net

17. The foreign exchange derivatives market could still be contributing substantially to resolving currency imbalances within sectors of the economy.

18. As Caballero, Cowan, and Kearns (2004) point out, foreign debt does not completely summarize currency mismatches, since it ignores the currency composition of debt and the response of income to exchange rate fluctuations.

outstanding position in the foreign exchange derivatives market because of the lack of reliable data on a cross-country basis. Also, foreign debt does not completely summarize currency mismatches, since it ignores the currency composition of debt, the value of other assets and liabilities, and the response of income to exchange rate fluctuations. Nonetheless, we find a tenuous positive association between net external debt and derivatives usage, with a pairwise correlation of 0.17 for the sample of countries. This is confirmed in figure 5.

Table 13. Net Foreign Debt and Derivatives Usage for Selected Economies, 2002[a]

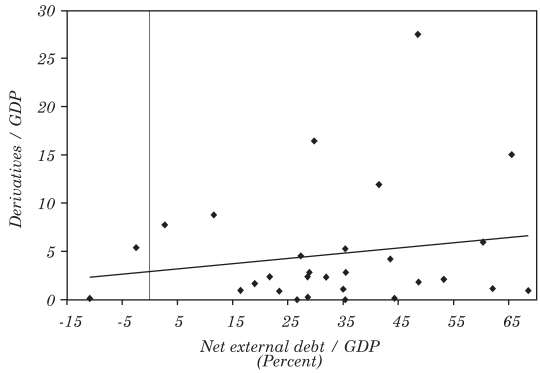
Country	*Net foreign debt / GDP(percent)*	*Net foreign debt / (X + M)(percent)*	*Derivatives 2001/GDP*
Argentina	35	106	10^{-3}
Australia	49	147	27
Austria	35	50	5
Brazil[b]	44	183	4
Canada	41	60	12
Chile	29	54	2
Colombia	29	95	$2\text{x}10^{-1}$
Czech Republic	–2	–2	5
Finland	22	37	2
France	3	6	8
Germany	12	21	9
Greece	60	195	6
Hungary	35	32	1
India	16	71	1
Indonesia	69	125	1
Israel	23	41	1
Italy	36	86	3
Mexico	19	37	2
Netherlands	30	32	16
New Zealand	66	135	15
Peru[b]	44	166	10^{-1}
Philippines	53	61	2
Poland	27	51	5
Portugal	49	89	2
Russia	–11	–22	10^{-1}
Slovenia	27	28	10^{-3}
Spain	32	72	2
Thailand	29	30	3
Turkey	62	129	1

Source: Authors' calculations, based on data from the IMF (2003), BIS (2002), and IMF's *International Financial Statistics*.

a. The table presents coefficient estimates from a panel OLS with fixed effects and the number of significant individual sectoral estimates for each country. Net foreign debt = [Debt Securities (liabilities) + other investment (liabilities)] – [debt securities (assets) + other investment (assets)].

b. For Brazil and Peru, derivatives were obtained directly from the corresponding central banks.

Figure 5. Net Foreign Debt and Derivatives Usage, 2002[a]



Source: Authors' calculations, based on data from the IMF (2003), BIS (2002), and IMF's *International Financial Statistics*.
a. Net foreign debt = [Debt Securities (liabilities) + other investment (liabilities)] – [debt securities (assets) + other investment (assets)].

One interpretation of this result is that economies with a more developed derivatives market also have more room to borrow in foreign currency. Behind this assessment is the implicit assumption that a more developed derivatives market consolidates a larger net bought position. Unfortunately, however, this says nothing about the association between the depth of the foreign exchange derivatives market and net foreign exchange exposures.

In the absence of direct data to measure aggregate currency mismatches across countries, we examine the association between a complementary measure of currency exposure derived from a regression analysis and the turnover in the currency derivatives market:

$$R_{i,t} = \alpha_0 + \alpha_1 \mathrm{MR}_t + \alpha_2 \Delta\mathrm{NER}_t + \varepsilon_t \,,$$

where R_i represents the monthly return of sector i, MR stands for the monthly return of the market, and DNER is the monthly change in the log of the nominal exchange rate relative to the dollar. Under this measure of exchange rate exposure, a sector/firm exhibits exchange rate exposure if its share value is influenced by changes in currency values after controlling for the market returns.[19] We used

19. Domínguez and Tesar (2001) estimate the exchange rate exposure of listed firms for eight economies. Chile and Thailand were the only emerging markets included.

the Morgan Stanley Capital Indices available at Bloomberg, at monthly frequency from January 1995 to June 2004. The stock market returns and nominal exchange rates were also obtained from Bloomberg. We consider eight sectors: consumer discretionary goods, consumer staples, financial, health care, industrial, material, telecommunications, and utilities.

The results suggest that countries with the lowest ratios of derivatives usage also have high currency exposure (see table 14 and figure 6). This is confirmed when we consider either the panel estimates or the number of sectors with significant exposure. Cowan, Hansen, and Herrera (in this volume) and Allayannis and Ofek (2001) present similar findings using data at the firm level.

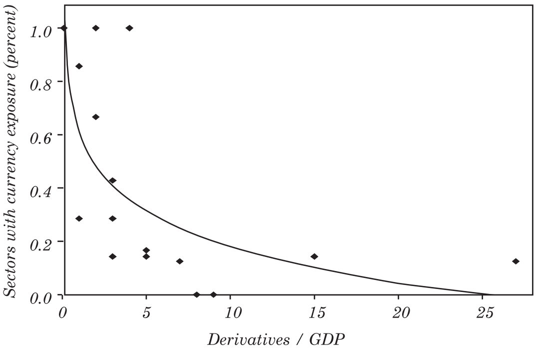
Table 14. Exposure by Regression Analysis for Selected Countries[a]

Country	*Exposure from a panel OLS (percent)*	*No. sectors with exposure*	*Derivatives[b] / GDP 2001*
Australia	insignificant	1 out of 8	27
Brazil	0.6	7 out of 7	4
Chile	1.08	8 out of 8	2
Czech Republic	0.25	1 out of 6	5
France	insignificant	0 out of 8	8
Germany	insignificant	0 out of 8	9
Hungary	–0.35	2 out of 7	1
Indonesia	0.07	6 out of 7	1
Italy	insignificant	1 out of 7	3
Japan	insignificant	1 out of 8	7
Malaysia	–0.28	3 out of 7	3
Mexico	–0.22	4 out of 6	2
New Zealand	insignificant	1 out of 7	15
Poland	0.22	1 out of 7	5
Russia	2.11	5 out of 5	10^{-1}
Thailand	–0.37	2 out of 7	3

Source: Authors´ calculations, based on Morgan Stanley Capital Indices (available at Bloomberg).
a. Estimation based on end-of-month changes in Morgan Stanley Capital Indices, nominal exchange rate, and stock market returns. Period covers January 1995 to June 2004.
b. Derivatives obtained from BIS (2002).

The evidence examined in this section thus indicates that while countries with a well develop derivatives market may increase their share of net foreign currency debt, they present lower degrees of exposure to fluctuations in the foreign exchange rate than do countries with a less developed market.

Figure 6. Exposure by Regression Analysis[a]



Source: Authors´ calculations, based on Morgan Stanley Capital Indices (available at Bloomberg).
a. Estimation based on end-of-month changes in Morgan Stanley Capital Indices, nominal exchange rate, and stock market returns. Period covers January 1995 to June 2004. Derivatives obtained from BIS (2002).

4. Benefits to Large Participants from Superior Information or Market Power

An important question in the foreign exchange market is whether there exists asymmetric information among traders that may be price relevant. Empirical work on the effect of currency positions on exchange rate movements is deficient, in part, because of the lack of data. In this area, we want to test the abilities of large participants in the Chilean foreign exchange market to forecast the level or first moment of the exchange rate. To do so, we evaluate the forecasting power of net currency positions taken in the derivatives and spot markets by these large players. [20]

The testing involves two observationally equivalent hypotheses. Either large participants have superior information about exchange rate movements and thus they take positions when they foresee a convenient movement in the foreign currency, or these participants have sufficient market power that their actions generate significant changes in the exchange rate. If we fail to find evidence of a forecasting ability on the part of large participants, neither hypothesis can be true.

20. A natural extension may be to test the relevance of integrated variables that gather spot and forward net positions.

The analysis of the relation between position-taking by large participants and exchange rate movements also helps identify the forces behind the exchange rate movements (Evans and Lyons, 2004). This approach to understanding exchange rate movements may be of interest to policymakers, who want to understand what drives changes in the nominal exchange rate over relatively short periods. They may draw on this evidence about the participants or types of flows affecting the exchange rates, since little else can be said to robustly explain large changes in the short term.

Wei and Kim (1997) and Klitgaard and Weir (2004) perform a similar exercise for the U.S foreign exchange market, using weekly data. Both papers find that players trade on noise rather than on asymmetric information, although they report a strong contemporaneous connection between net positions and exchange rates. We are not aware of any study analyzing this question using daily data.

Our dataset covers nearly nine years of daily data (from January 1995 to June 2004). This generates 2,870 observations for the largest Chilean foreign exchange market players, although in implementing the test we focus on the free-floating period beginning in September 1999.

For the derivatives market, we employ trading (forward) flows in U.S. dollars categorized by the institution type of each dealer's trading partners, where trade flows correspond to net purchases of outright forward trades (net forward position). Thus, the net position (NET_POS) for group or participant *j* at day *t* adds agents' net positions within the group, and is constructed as follows:

$$\text{NET\_POS}_{j,t}^{D} = \sum \begin{bmatrix} \text{Purchases}_{i,t} - \text{Sales}_{i,t} \\ -\left(\text{Expired Purchases}_{i,t} - \text{Expired Sales}_{i,t}\right) \end{bmatrix}.$$

Our measure of net position is a proxy—for the derivatives market—of the order flow employed by Evans and Lyons (2002). While net positions are defined in this paper as the difference between purchases and sales among dealers and their various clients at the end of the day, order flows are the difference between buyer- and seller-initiated orders within the interdealer market. Lyons (2001) and Evans and Lyons (2002), among other, provide empirical evidence showing that order flow in the spot foreign exchange market covaries positively with the exchange rate over horizons of days and weeks, and it may be a good complement for macroeconomic fundamentals explaining and forecasting the nominal exchange rate. Dealers' (or banks') trading is disaggregated by trade with pension funds, nonbank financial agents, and cross-border clients. We also distinguish the trading that occurs between residents (banks, firms, pension funds, and the nonbank financial sector) and foreign clients.[21]

We implement a straightforward procedure that resembles Meese and Rogoff (1983), Mark (1995), Wei and Kim (1997), and Evans and Lyons (2002). We test the relevance of macroeconomic fundamentals and variables from the microeconomic structure of the foreign exchange market for predicting the nominal exchange rate. In a regression equation, net positions (x_t) are included as a regressor.[22] We rely on both in-sample and out-of-sample evidence to assess the degree of predictability of net positions. The advantage of out-of-sample evaluation procedures is that they implicitly test the stability of the estimated coefficients, and they therefore provide a more stringent and realistic hurdle for models (or variables) to overcome than do in-sample procedures. The evaluation criterion in this paper uses the root-mean-squared error comparing the forecasting performance of trade flow with respect to a simple random walk. Numerous econometric studies find that the random walk model provides more accurate forecasts than other models of the exchange rate. The random walk is thus a natural benchmark for judging forecast performance. The regression analysis reduces to the following equation:

$$\Delta \log(\mathrm{NER})_{t+1} = \alpha_1 + \alpha_1 x_t + \varepsilon_{t+1} ,$$

which will improve forecast accuracy relative to the random walk forecast:

$$\Delta \log(\mathrm{NER})_{t+1} = \alpha_1 + \varepsilon_{t+1} .$$

We use foreign exchange rate returns for the peso-dollar exchange rate, defined as the log difference of the nominal exchange rate (*dólar observado*).

21. We are not able to capture the net position of firms with firms or of firms with the nonbank financial sector. Net interdealer (banks) trading is zero in our database.

22. While all of these works suffer from simultaneous equation bias since explanatory variables are all endogenous (that is, determined within the economic system), it is unclear why biased coefficients would be a problem for a forecasting exercise. If the covariance matrix of the structural errors is homoskedastic and stable over time, forecasts from biased coefficients would be superior to forecasts from structural parameters (Neely and Sarno, 2002). A more serious problem emerges—for an out-of-sample forecasting exercise—from the persistence of the variables, which makes the coefficient estimates inconsistent.

We defined our sample periods based on the availability and reliability of the individual series. We perform this comparison for the following net positions: banks with foreign clients; nonbank domestic agents with foreign clients; banks with pension funds; banks with the nonbank financial sector; banks with the nonfinancial sector; residents with foreign clients; banks with other domestic agents; and the aggregate net position. Results are in table 15. We report the value of the t statistic of parameter β and Theil's U statistic for the out-of-sample performance. For the derivatives market, we also report the forecast performance for changes thirty-five days ahead in the nominal exchange rate.[23]

The in-sample estimations fit quite well for the first periods, but the out-of-sample results are less convincing and do not show evidence of forecasting ability for the trade flow variables tested. These findings suggest that the main participants in the derivatives market do not have significant market power or asymmetric information. We also performed forecasting exercises for weekly net positions, and the results point to the same direction.

To provide intuition on the above results, we graph the contemporaneous relation between the exchange rate and net forward positions. Figure 7 plots the monthly nominal exchange rate movements and changes in the net positions currency derivatives held by some participants from January 1995 to June 2004.[24] An observation in the upper-left quadrant of each panel represents a month when participants, as a group, increased their holdings of short contracts in the foreign currency relative to long contracts, and the peso depreciated relative to the dollar in the same month. After fitting a straight line by OLS, we observe a tenuous negative relationship between the change in the net position and the contemporaneous movement of the exchange rate. This simple graphic analysis confirms that the main participants in the derivatives market are not consistently taking positions in a manner that allows them to make some extra pesos, but rather are probably hedging positions in underlying investments or sales.

For the spot market, we follow the same path and construct the spot net position variable as follows:

$$\mathrm{NET\_POS}_t^S = \sum \left(\mathrm{Purchases}_{i,t} - \mathrm{Sales}_{i,t} \right).$$

23. Alarcón, Selaive, and Villena (2004) report an average duration of five weeks in forward contracts.

24. We also graphed one-month-ahead changes in the nominal exchange rate, and the results were unaltered.

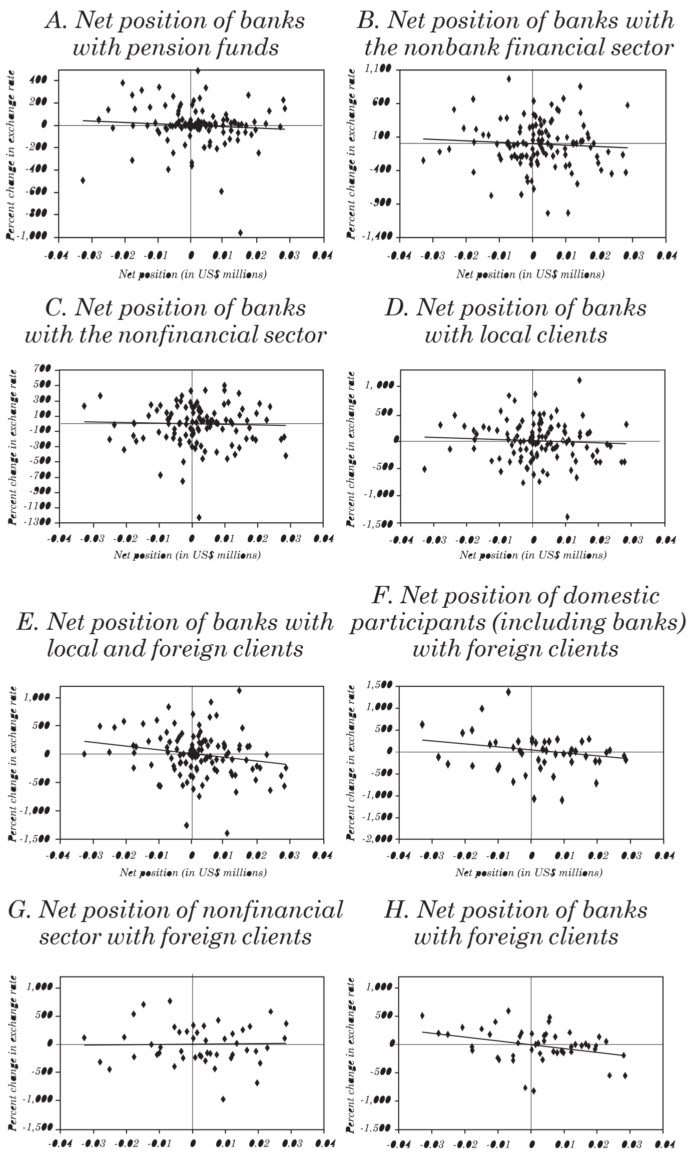
Table 15 . Forecast Performance: Derivatives Market

		Forecasting ability[a]			
		In sample		Out of sample	
Trading relation	*Sample period*	$\Delta log(NER)_{t+1}$ (*t statistic*)	$\Delta log(NER)_{t+35}$ (*t statistic*)	$\Delta log(NER)_{t+1}$ (*Theil's U*)	$\Delta log(NER)_{t+35}$ (*Theil's U*)
Banks with foreign clients	Dec 2000 – June 2004	**2.36**	0.60	1.003	0.999
Nonbank domestic agents with foreign clients	Dec 2000 – June 2004	1.41	0.51	1.002	1.041
Banks with pension funds	Sept 1999 – June 2004	1.45	**2.39**	1.001	1.001
Banks with the nonbank financial sector	Sept 1999 – June 2004	0.47	0.62	1.001	1.001
Residents with foreign clients	Dec 2000 – June 2004	**2.34**	0.69	1.000	1.035
Banks with the nonfinancial sector	Sept 1999 – June 2004	**2.14**	0.01	0.999	1.001
Banks with other domestic agents	Sept 1999 – June 2004	0.15	**1.91**	1.001	1.001
Aggregate net position	Sept 1999 – June 2004	0.89	**2.18**	1.000	1.001

Source: Authors' calculations, based on information provided by the Central Bank of Chile.

a. A Theil's U of less than one indicates a better forecast with respect to the random walk. Out-of-sample rolling forecasts start at the middle of the corresponding sample period. Bold numbers represent significance level of 0.1. Newey-West HAC standard errors and covariance under Andrews' (1991) automatic lag truncation method.

Figure 7. Net Forward Positions and Exchange Rate Movement[a]



Source: Authors' calculations, based on data from the Central Bank of Chile.

a. Monthly Changes from January 1995 to June 2004. Panels f, g, and h include data only for the period December 2000 to June 2004.

The results are presented in table 16 for the following net positions: banks with pension funds; banks with the nonbank financial sector; bank with the nonfinancial sector; banks with other domestic agents; and the aggregate net position. The table reveals that none of the net spot positions have a significant forecasting ability out-of-sample. In-sample fitting, however, suggests that a regular analysis of these series may be worth pursuing to improve our understanding of current movements in the nominal exchange rate. We also performed forecasting exercises for weekly net positions, and the results point to the same direction.[25]

Overall, these findings indicate that the main players in foreign exchange markets do not accurately forecast the nominal exchange rate. They thus cast doubt on the idea that participants have either superior information or significant market power (or both) from which they consistently profit.

5. Concluding Remarks

The evidence in this paper supports the view that development of the foreign exchange derivatives market is valuable for reducing aggregate currency risk. On the issue of effectiveness, our cross-country evidence suggests that development of the foreign exchange derivatives market helps a country decrease its degrees of exposure to fluctuations in the foreign exchange rate, and that it does not increase the volatility of its foreign exchange rate. To explore the issue of volatility more deeply, we used a unique database containing detailed statistics on foreign exchange market operations by private agents in Chile to test a pool of models and evaluate whether derivatives exacerbated the volatility of exchange rate after the implementation of the free float. We consistently were not able to find a significant relationship between activity and volatility.

With regard to the efficiency of the foreign exchange derivatives market, we examined evidence on the ability of large market participants to forecast or affect the level or first moment of the nominal exchange rate in the free-floating period. Our results on the relation between their net positions in the spot and derivatives markets and the foreign exchange rate cast doubt on the hypothesis of asymmetric information or market power in the foreign exchange spot and derivatives markets.

25. The results are available upon request.

Table 16. Forecast Performance: Spot Market

		Forecasting ability[a]	
Trading relation	*Sample period*	*In sample (t statistic)*	*Out of sample (Theil's U)*
Banks with pension funds	Sept 1999 – June 2004	**2.70**	0.997
Banks with the nonbank financial sector	Sept 1999 – June 2004	**3.55**	0.995
Banks with the nonfinancial sector	Sept 1999 – June 2004	**2.73**	0.997
Banks with other domestic agents	Sept 1999 – June 2004	**1.85**	0.999
Aggregate net position	Sept 1999 – June 2004	**1.99**	1.002

Source: Authors' calculations, based on information provided by the Central Bank of Chile.

a. A Theil's U of less than one indicates a better forecast with respect to the random walk. Out-of-sample rolling forecasts start at the middle of the corresponding sample period. Bold numbers represent significance level of 0.1. Newey-West HAC standard errors and covariance under Andrews' (1991) automatic lag truncation method.

This paper constitutes an attempt to explore empirically the overall effects of the foreign exchange derivatives market on aggregate currency risk. This issue merits further research, given the increased adoption of floating exchange rate regimes by many developing and emerging market economies, together with general concerns about the risks associated with derivatives, currency mismatches, and exchange rate volatility. Empirical evidence based on panel and time series models for both advanced and emerging market economies would prove insightful, although in principle such studies are somewhat limited by the availability of data.

APPENDIX
Classification of Economies

	Category	
Country	*1998*	*2001*
Argentina	Emerging	Emerging
Australia	Emerging	Advanced
Austria	Advanced	Advanced
Belgium	Advanced	Advanced
Brazil	Emerging	Emerging
Canada	Advanced	Advanced
Chile	Emerging	Emerging
Colombia	—	Emerging
Czech Republic	Emerging	Emerging
Denmark	Advanced	Advanced
Finland	Advanced	Advanced
France	Advanced	Advanced
Germany	Advanced	Advanced
Greece	Advanced	Advanced
Hong Kong	Emerging	Emerging
Hungary	Emerging	Emerging
India	Emerging	Emerging
Indonesia	Emerging	Emerging
Ireland	Advanced	Advanced
Israel	—	Emerging
Italy	Advanced	Advanced
Japan	Advanced	Advanced
Malaysia	Emerging	Emerging
Mexico	Emerging	Emerging
Netherlands	Advanced	Advanced
New Zealand	Advanced	Advanced
Norway	Advanced	Advanced
Poland	Emerging	Emerging
Portugal	Advanced	Advanced
Russia	Emerging	Emerging
Slovak Republic	—	Emerging
Slovenia	—	Emerging
South Africa	Emerging	Emerging
South Korea	Emerging	Emerging
Spain	Advanced	Advanced
Sweden	Advanced	Advanced
Switzeland	Advanced	Advanced
Thailand	Emerging	Emerging
Turkey	—	Emerging
United Kingdom	Advanced	Advanced

Sources: International Monetary Fund, J.P. Morgan-Chase and Jadresic and others (2003).

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Managing the Capital Account

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Globalization has been under attack over the last few years. Activists, famous academics, and commentators of various stripes have mounted a systematic campaign against free trade in goods and, especially, in financial claims.[1] One of the latest manifestations of this antiliberalization mood was the failure of the World Trade Organization (WTO*)* Cancún meeting in September 2003. The antiglobalization lobby has focused on a number of issues, including the effects of freer trade on income distribution and social conditions and the alleged negative effects of capital mobility on macroeconomic stability. For example, in his critique of the U.S. Treasury and the International Monetary Fund (IMF), Stiglitz (2002) argues that pressuring emerging and transition countries to relax controls on capital mobility in the 1990s was highly irresponsible. Stiglitz goes so far as to argue that the easing of controls on capital mobility was at the center of most (if not all) of the recent currency crises in emerging markets—Mexico 1994, East Asia 1997, Russia 1998, Brazil 1999, Turkey 2000, and Argentina 2001. These days, even the IMF seems to criticize free capital mobility and to support capital controls (at least to some degree). Indeed, in a visit to Malaysia in September 2003 Horst Koehler, then the Fund's Managing Director, praised the policies of Prime Minister Mahathir Mohamad, in particular the country's use of capital controls in the aftermath of the 1997 currency crises.[2]

The debate on capital account convertibility and capital account management has been strongly influenced by specific country experiences. In particular, Chile's experience with controls on capital inflows in the 1990s has attracted considerable attention from policy

I thank Roberto Alvarez for excellent assistance.

1. The protectionist agricultural policies of the advanced countries have undoubtedly helped fuel the antiglobalization sentiments.
2. *Financial Times,* 15 September 2003, p. 16.

External Vulnerability and Preventive Policies, edited by Ricardo Caballero, César Calderón, and Luis Felipe Céspedes, Santiago, Chile.

analysts and academics and has been the subject of numerous studies.[3] Also, Malaysia's imposition of controls on capital outflows in the aftermath of the Asian debt crisis has generated extensive debates on the benefits of imposing capital controls as a way of managing financial and currency crises (Dornbusch, 2002; Kaplan and Rodrik, 2002).

These debates on the pros and cons of capital controls have taken place at the same time that most countries in the world have effectively moved toward a greater degree of capital mobility. Table 1 presents data on a new index on capital account restrictions for six regions in the world for the period 1970–2000. This index is constructed by combining data from Quinn (2003) and Mody and Murshid (2002), with country-specific information; it ranges from 1 to 100, with higher numbers denoting a greater degree of capital mobility. As may be seen in the table, every region in the world experienced an increase in the degree of capital mobility during the period under study. The industrial countries experienced the greatest progress toward capital account liberalization, while the countries in the Middle East and Northern Africa moved at the slowest pace.

Table 1. The Evolution of Capital Account Openness, 1970–2000[a]

	1970–89			*1990–2000*		
Group of countries	*Mean*	*Median*	*Standard deviation*	*Mean*	*Median*	*Standard deviation*
Industrial	66.5	75	21.7	88.8	100	15.2
Latin America and the Caribbean	49.2	50	22.5	65.4	75	22.0
Asia	41.3	37.5	25.8	53.2	50	24.0
Africa	41.3	37.5	18.4	49.1	50	19.0
Middle East and North Africa	62.3	75	25.0	66.3	75	23.4
Eastern Europe	—	—	—	60.0	50	17.2

Source: Author's construction, using the methodology described in the text.
a. The capital account openness index ranges from zero to one hundred, with higher values indicating a greater degree of openness.

This paper analyzes the emerging and transition economies' experience with capital account convertibility, capital account management, and capital controls. The approach I take in this paper recognizes directly that controlling capital mobility is likely to have

3. See, for example, De Gregorio, Edwards, and Valdés (2000).

costs and benefits. Most of the potential costs are related to possible increases in corruption and to microeconomic inefficiencies.[4] Benefits, on the other hand, are potentially related to reducing the country's vulnerability to external crises and helping the authorities achieve specific macroeconomic objectives, including monetary policy and exchange rate objectives. In discussing theses issues, I focus on controls on both capital inflows and capital outflows, and I briefly discuss the important issue of the sequencing of reforms and the timing of liberalization of the capital account of the balance of payments. The core of the paper comprises an empirical analysis of the relation between capital account restrictions and vulnerability to crises. I use a new cross-country data set to analyze two specific issues: whether capital controls reduce the probability of a major external crisis and whether restrictions on capital mobility reduce the negative consequences of external crises.

The paper is organized as follows. Section 1 deals with the main issues raised in recent policy controversies on capital account management. I focus on the policy objectives in countries that restrict capital mobility, and I discuss the type of policy interventions, or controls, proposed to deal with these objectives. Section 2 evaluates the evidence on the effectiveness of restricting capital mobility. I divide the discussion into three parts: restrictions on capital inflows, restrictions on capital outflows, and the appropriate sequencing of economic liberalization. Section 3 reports some new results on the relation between capital account restrictions and external crises. This analysis focuses on current account reversals and addresses whether restrictions on capital mobility reduce the probability of reversals. I also investigate whether capital controls reduce the costs of these reversals, once they have occurred. Finally, Section 4 provides some concluding remarks.

1. Managing the Capital Account and Restricting Capital Mobility: Basic Policy Objectives

Most well-trained economists would agree that there are trade-offs associated with the imposition of capital controls. On the one hand, not allowing free trade in financial claims has potential efficiency

4. On the costs associated with capital controls, see the discussions and empirical analyses in Forbes (2003), Desai, Foley, and Hines (2004), and Gallego and Hernández (2003).

consequences, including the misallocation of resources, a decline in investment, and an increase in corruption.[5] On the other hand, restricting capital mobility could have some potential benefits in the emerging and transition countries, such as the possible reduction in vulnerability to crises and increased freedom for the authorities to pursue domestic policy objectives. Whether the costs offset the benefits is a complex empirical question, whose answer will depend on the specificities of each particular country. Cross-country studies that relate aggregate economic performance, such as average GDP growth, to the presence of capital controls (and other variables) are an attempt to deal with this issue in a reduced-form fashion (see Eichengreen, 2001, for a review of this type of study).

In this section, I discuss the policy objectives of capital controls and explore policymakers' goals in restricting capital mobility. Although I do not deal with the costs of capital account restrictions, the analysis presented here puts the issues into perspective and organizes the discussion on managing the capital account.[6]

Proponents of capital account restrictions in emerging and transition economies argue that limiting capital mobility will allow the emerging and transition economies to achieve several policy goals. Generally speaking, modern discussions on the subject emphasize the following four policy objectives: reducing vulnerability to external shocks and potential financial crises; avoiding real exchange rate appreciation; increasing the degree of monetary independence; and reducing the costs of currency crises. I discuss each in turn.

—Reducing vulnerability to external shocks and potential financial crises. Most authors argue that this objective would be best achieved by limiting short-term—or speculative—capital movements. This is generally an argument for the imposition of restrictions on capital inflows, in particular, those that are short term. The idea behind this proposition is very simple. It is based on the notion that if capital does not flow in to begin with, it will not flow out during times of macroeconomic tension—and if capital does not flow out (in other words, if there is no "capital flight"), then a currency crisis is very unlikely.[7] Many authors that support this view argue that, because of moral

5. See Rogoff (1999).

6. See, however, Forbes (2004), Desai, Foley, and Hines (2004), and Gallego and Hernández (2003) for good discussions on the costs of these policies.

7. Controls on inflows are supported by a number of prominent economists, including Stiglitz, Portes, Krugman, and Eichengreen.

hazard and other market imperfections, domestic firms and banks will overborrow from abroad in the absence of capital control (McKinnon and Pill, 1999). Supporters of this policy almost invariably refer to Chile's experience with controls on capital inflows to illustrate the merits of this system. Stiglitz, the ardent critic of globalization, has said, "You want to look for policies that discourage hot money but facilitate the flow of long-term loans, and there is evidence that the Chilean approach, or some version of it, does this."[8] Ito and Portes (1998) and Eichengreen (1999), among others, endorse this view. Some supporters of this view go beyond the case of Chile, arguing that the recent experiences of China and India provide evidence that limiting capital mobility (to inflows and outflows) reduces the likelihood of external financial crises (Stiglitz, 2002).

—Avoiding real exchange rate appreciation. A common problem during a market-oriented reform process is that the country undertaking the reforms tends to be flooded with capital inflows. This generates forces toward real exchange rate appreciation and thus reduces the country's degree of international competitiveness. Calvo and others (1993) document this phenomenon in great detail for the case of the Latin American nations. If, as many authors argue, capital inflows overshoot their long-run (sustainable) level in the short term, the real appreciation will be destabilizing and will have to be reversed at some time in the future. Furthermore, in countries with fixed (or predetermined) nominal exchange rates, this reversal will require a reduction in domestic nominal prices and is likely to generate a recession. Discussions on the relation between capital controls and monetary policy also emphasize the costs of sterilizing large capital inflows in emerging and transition economies. It is precisely for this reason that some authors—including those that deal with the "sequencing of liberalization"—argue that capital controls, and in particular controls on inflows, will help avoid real exchange rate appreciation during the transition. (For more information on the on the sequencing of reform, see section 2.3 of this paper.)

—Increasing the degree of monetary independence. One of the alleged virtues of capital controls is that, in the presence of a pegged exchange rate, they give the country in question greater control over its monetary policy. That is, in the presence of controls, the local monetary authorities

8. *The New York Times,* 1 February 1998.

will have the ability to affect domestic short-term interest rates. In fact, this increased control over monetary policy is one of the reasons given in support of the imposition of this type of control in the Asian nations (Summers, 2000).[9] This idea is associated with the so-called impossibility of the Holy Trinity: it is not possible to simultaneously have free capital mobility, a pegged exchange rate, and an independent monetary policy.

Some authors argue that the most efficient way to deal with this problem is for emerging and transition countries to adopt a flexible exchange rate (Fischer, 2003). This view became particularly popular in the aftermath of the currency crises of the 1990s, when the economic profession adopted the "two-corner" view of exchange rates regimes. More recently, however, there has been a revival of interest in intermediate exchange regimes and, thus, in using some form of restrictions on capital movements to allow for greater monetary independence. This "monetary independence" argument calls for policies that decouple domestic and international interest rates. That is, to achieve this policy objective, countries may, in principle, impose controls on inflows or on outflows. The challenge, of course, is to select the policy that allows for the greatest monetary independence at the lowest cost in terms of distortions. Economists increasingly argue that the objective of monetary independence is best achieved by implementing some form of restriction on capital inflows, or at least on short-term ones.

—Reducing the costs of currency crises. Some authors, including Krugman (1999) and Kaplan and Rodrik (2002) argue that temporary controls on capital outflows would allow countries that have suffered a currency crisis to lower interest rates and establish progrowth policies.[10] According to this view, controlling capital outflows would also give crisis countries additional time to restructure their financial sector in an orderly fashion. Controls are to be dismantled once the economy is back on its feet. As should be clear, this is an argument for controlling capital outflows in the aftermath of a currency crisis. This same argument calls for tightening controls in the case of countries that already had some sort of control before the crisis.

9. This is an old proposition dating back at least to the writings of Robert Mundell in the early 1960s. Recently, however, it has acquired renewed force as a result of the exchange rate policy debates.

10. See also Stiglitz (2002).

This will allow the country to take a “time out” during a difficult period and gain time to put things in order. Much of the recent discussion on this particular objective of capital controls is based on alternative interpretations of the Malaysian experience in the aftermath of the 1997 Asian crisis. A related argument says that countries that are suffering crisis symptoms, and appear to be heading toward a currency collapse, should impose temporary controls on outflows as a way to avoid the crisis. The controls on outflows should be relaxed once the crisis has been avoided and macroeconomic conditions “normalized.”[11]

Historically, capital controls have also played an important role in policies aimed at intervening heavily in the domestic capital market. Until the late 1980s and early 1990s, restrictions on capital mobility were an integral component of financial policies that subsidized domestic interest rates and directly allocated credit to favored sectors. These policies, which were often referred to as “financial repression,” relied on nonmarket instruments and strived at maintaining low interest rates as a way of lowering the costs of capital. Under these circumstances, domestic interest rates tended to be lower than international interest rates. The country in question would thus experience severe capital flight in the absence of capital controls on outflows. In recent years, however, these “financial repression” policies have largely been abandoned.

Table 2 provides a summary of the policy objectives that the modern literature on macroeconomic management associates with capital controls. The table includes a brief description of the mechanisms that are supposed to help achieve these objectives, information on whether the specific policy objective calls for controls on inflows, control on outflows, or both, and some general comments.

Whether capital controls have indeed been effective in helping achieve the policy objectives in table 2 is, ultimately, an empirical question. In the rest of this paper, I review the existing country evidence (section 2), and I discuss new results pertaining to the relation between capital account restrictions, crisis vulnerability, and the costs of external crises (section 3).

11. This policy objective may be combined with any (or all) of the previous three policy goals. For instance, a country may apply controls on inflows in order to increase its monetary independence. If it faces a speculative attack, it may temporarily tighten its controls on outflows.

Table 2. Summary of the Objectives of Capital Account Management Policies

Policy objective	*Mechanisms at work*	*Type of restrictions*	*Comments*
Reduce vulnerability to external crises	— Tilt capital flows towards longer maturities. — Avoid overborrowing by domestic firms; reduce exposure to balance sheet effects.	— Controls on inflows are favored, in particular restrictions on short-term speculative flows.	— Chilean-type controls are considered to be the best practice. — Colombia's experience also relevant. — Whether to restrict fixed income or equity flows seems important (Korea). — Bank supervision is an important policy that could deal with most of the vulnerabilities generated by the inflows.
Avoid excessive real exchange rate appreciation	— Controlling inflows reduces hikes in aggregate expenditure. — Financing expenditure on nontradables (including real estate and construction) may lead to significant appreciation. — It is important to determine whether capital inflows overshoot following reforms.	— Controls on inflows are favored. — A key problem with inflows is that sterilization can be very costly. — The key is to reduce the percentage of the flows spent on nontradables.	— The real appreciation problem seems to affect different countries diversely: in the 1990s, it was severe in Latin America, but much less so in Southeast Asia.

Table 2. (continued)

Policy objective	*Mechanisms at work*	*Type of restrictions*	*Comments*
Independent monetary policy	— With free capital mobility, domestic and international interest rates are closely linked, which makes it hard to pursue an independent monetary policy. — Fear of floating is an issue. — This is particularly the case in countries with predetermined nominal exchange rates, where monetary policy is endogenous.	— Either controls on inflows or controls on outflows could, in principle, unhinge domestic and international interest rates.	— Independent monetary policy could be achieved under flexible exchange rates. — Countries that combine flexible rates with inflation targeting have done well.
Reduce costs of crises and make crisis resolution policies more effective	— The traditional (IMF-associated) post crisis policies include a severe hiking of domestic interest rates. — This generates recessionary forces and increases bankruptcies. — Lowering interest rates could provide some alleviation; this requires controls on outflows to avoid capital flight.	— Calls for temporary controls on outflows. — Temporary controls on outflows are also advocated whencountries are facing speculativeattacks or moving toward a crisis.	— A key aspect of these policies is the temporary nature of the tighter controls. — These policies may be—and historically have been— combined with controls on inflows.

Source: Author's elaboration.

2. How Effective Are Capital Controls?

This section discusses the empirical evidence on the effectiveness of capital controls. I have divided the discussion in three parts: controls on inflows; the evidence on controls on outflows; and transitional issues and the sequencing of economic liberalization. In each of these subsections, I refer to the controls' policy objectives discussed above.

2.1 Controls on Inflows

As pointed out above, supporters of restricting capital mobility through controls on inflows have frequently referred to Chile's experience with this policy as an example of what should be done. This section analyzes two episodes in Chile's recent history when capital controls on inflows were imposed. The first episode took place in the late 1970s and early 1980s, while the second took place in 1991–99. The main conclusion from this analysis is that the positive effects of Chile's controls on capital inflows have been somewhat (but not completely) exaggerated. Because of this adulteration of the historical record, Chile has become part of the folklore, and it is one of the most important exhibits in the activists' case against capital mobility. The rest of the subsection is divided into two parts, based on Chile's experience with controls on inflows in the 1970s and the 1990s.[12]

Chile's early experience with capital controls

In 1977, three years after initiating a major market-oriented reform effort, Chile began to receive increasingly large volumes of foreign capital in the form of syndicated bank loans.[13] The vast majority of these funds was intermediated by local banks, which provided foreign-currency-denominated loans to final users. The authorities feared that these inflows would pressure the real exchange rate toward appreciation and thus have a negative effect on export performance. Mostly for this reason, starting in 1977 the authorities implemented a novel system for slowing down the flow of capital into the country. This policy was based on unremunerated reserve

12. Chile is not the only country that has relied on this mechanism. Colombia in the 1990s is another notable example. See Cárdenas and Barrera (1997) and Edwards (2000a).

13. On Chile's market-oriented reforms, see, for example, Edwards and Cox-Edwards (1991).

requirements imposed on short- and medium-term capital inflows. Under these regulations, loans with maturities below twenty-four months were forbidden, and those with maturities from twenty-four to sixty-six months were subject to non-interest-yielding reserve requirements ranging from 10 percent to 25 percent of the value of the loan.[14]

Three things stand out from this episode. First, total foreign indebtedness increased very rapidly despite the existence of these restrictions, almost tripling between 1978 and 1982. It is important to note that most of this new debt was private sector debt. In fact, private (nominal) foreign debt increased by more than twenty-three times between 1973 and 1981, growing at an average annual rate of almost 40 percent in real terms. Second, the level of foreign indebtedness of the private banking system also grew very rapidly. Third, virtually all of these funds were contracted in maturities exceeding twenty-four months. That is, given that the unremunerated reserve requirements were in effect throughout the period, Chile did not receive short-term (or, as it is some times called, speculative) capital inflows.

In spite of these strict controls on inflows, Chile continued to receive very large volumes of foreign funds: in 1980 net inflows exceeded 11 percent of GDP, and in 1981 they were equal to 14 percent of GDP. In 1982, a combination of factors led to a sudden stop of capital inflows into Chile. In the absence of foreign funds, the authorities were unable to defend the fixed exchange rate, and the country suffered a massive currency crisis in June 1982. Within a few months, the peso-dollar rate, which had been fixed at 39 pesos per dollar, was 120 pesos per dollar. The period that followed the devaluation crisis was overly traumatic: in 1982 GDP fell 14 percent, unemployment surpassed 25 percent, and the banking sector suffered a major collapse and had to be bailed out by the government at a cost that exceeded 25 percent of GDP. All of this took place in an environment in which short-term capital inflows had been controlled quite severely.

This historical episode in Chile provides an important element in the evaluation of the effectiveness of restrictions on capital mobility. It suggests that restrictions on capital inflows are unlikely to reduce a country's degree of vulnerability. This is particularly the case if bank supervision is lax and antiquated, as was the case in Chile at the time. Moreover, this episode shows that countries can face

14. For greater detail, see Edwards and Cox-Edwards (1991) and Harberger (1985).

extremely severe currency crises even if so-called speculative capital is restricted. All it takes is that capital flowing into the country—in this case, longer-term capital—suddenly stops flowing, forcing the country to put into place a major adjustment program.[15]

Chile's experience with controls on capital inflows in the 1990s

Chile reintroduced restrictions on capital inflows in June 1991. Initially, all inflows were subject to a 20 percent reserve deposit that earned no interest. For maturities of less than a year, the deposit applied for the duration of the inflow, while for longer maturities, the reserve requirement lasted one year. In July 1992, the rate of the reserve requirement was raised to 30 percent, and its holding period was set at one year, regardless of the length of stay of the flow. Its coverage was extended to trade credit and to loans related to foreign direct investment. Additional changes were introduced in 1995, when the reserve requirement coverage was extended to Chilean stocks traded on the New York Stock Exchange (American Deposit Receipts), and to "financial" foreign direct investment (FDI). In June 1998, pressure from the East Asian crisis led the authorities to lower the rate of the reserve requirement to 10 percent, and in September of that year the deposit rate was reduced to zero. Throughout this period Chile also regulated foreign direct investment: FDI was subject to a three-year minimum stay in the country until 1992, when the minimum stay was reduced to one year.[16]

The authorities had three goals in mind when they reintroduced the control policy in 1991:

—First, to slow down the volume of capital flowing into the country and to tilt its composition toward longer maturities. Interestingly, when the controls were put in place in April 1991, there was no explicit talk about reducing the country's vulnerability to a speculative attack or currency crisis.

—Second, to reduce (or at least delay) the real exchange rate appreciation that stemmed from these inflows.

—Third, to allow the Central Bank to maintain a high differential between domestic and international interest rates. This was expected

15. On the economics of sudden stops of capital inflows, see, for example, Calvo (2003).

16 For further detail, see Massad (1998a, 1998b), De Gregorio, Edwards, and Valdés (2000), and Budnevich and Lefort (1997).

to support the government's effort to reduce inflation to the lower single-digit level. It was further expected that the controls would reduce the country's vulnerability to international financial instability (Cowan and De Gregorio, 1998; Massad, 1998b; Valdés-Prieto and Soto, 1996a; Edwards, 1999; and De Gregorio, Edwards, and Valdés, 2000).

Chile's controls were thus expected to help achieve three of the four policy objectives discussed in the preceding section. In the rest of this subsection, I discuss the extent to which these goals were accomplished.

Chile's system of unremunerated reserve requirements is equivalent to a tax on capital inflows. The rate of the tax depends on both the length of time the funds stay in the country and the opportunity cost of these funds. As shown by Valdés-Prieto and Soto (1996a) and De Gregorio, Edwards, and Valdés (2000), the tax equivalent for funds that stay in Chile for *k* months, is given by the following expression:

$$\tau(k) = \left[r^* \left(\frac{\lambda}{1-\lambda} \right) \right] \left(\frac{\rho}{k} \right), \tag{1}$$

where r^* is an international interest rate that captures the opportunity cost of the reserve requirement, λ is the proportion of the funds that has to be deposited at the Central Bank, and ρ is the period (measured in months) that the deposit will be kept in the Central Bank.

An inspection of equation (1) reveals two characteristics of the Chilean capital controls scheme of the 1990s. First, the tax rate is inversely related to the time the funds are in the country. This was exactly the intent of the policy, as the authorities wanted to discourage short-term inflows. Notice, however, that the tax is quite high even for a three-year period. In 1997, for example, the average tax for three-year-funds was 80 basis points. Second, the tax equivalent may vary through time, both because the rate of the required deposit may be altered (as it indeed was) and because the opportunity cost of the funds (r^* in equation (1)) changes through time.

Data on the composition of capital inflows into Chile reveal marked change following the imposition of the controls in 1991, with short-term flows (that is, less than a year) declining steeply relative to longer-term ones (De Gregorio, Edwards, and Valdés, 2000). The fact that this change in composition happened immediately after the implementation of the policy provides some support for the view that the policy has indeed affected the composition of inflows. These data also show that, with the exception of a brief decline in 1993, the total volume of capital inflows into the country continued to increase until 1998 (see Edwards, 1999, for details). De Gregorio, Edwards, and Valdés (2000) use data obtained from the Central Bank of Chile to calculate the maturity structure of Chile's total debt. According to their results, Chile's short-term debt as a proportion of total debt declined from 19 percent in 1990 to less than 5 percent in 1997.

A simple analysis of the raw data, however, tends to understate Chile's vulnerability to shocks stemming from international financial instability. Under standard practice, data flows have been classified as "short term" or "long term" on the basis of contracted maturity. Thus flows that are contracted for a year or less are classified as short term, while those with a contracted maturity in excess of 365 days are registered as long term. It is possible to argue, however, that when measuring a country's degree of vulnerability to financial turmoil, what really matters is "residual" maturity, measured by the value of the county's foreign liabilities that mature within a year. The Bank for International Settlements provides data on residual maturity for loans extended by G10 banks to a group of selected of Latin American and East Asian countries. An analysis of those data provides important insights. First, the percentage of short-term debt does not look as low when data on residual maturity are used as when contracting maturities are considered. Second, the Bank for International Settlements data indicate that Chile's short-term residual debt was not significantly lower in the mid-1990s than that of Argentina (a country with no capital restrictions) and it was higher than that of Mexico (another Latin American country without controls): in mid-1996, short-term residual debt was 53 percent of total debt in Argentina, 58 percent in Chile, and 49 percent in Mexico.

A number of authors use regression analysis to investigate the determinants of capital flows in Chile. Soto (1997) and De Gregorio, Edwards, and Valdés (2000), for example, use vector autoregression analysis on monthly data to analyze the effects of changes in the inflows' tax equivalent. Their results indicate that the tax on capital movements discouraged short-term inflows. These analyses suggest, however, that the reduction in short-term flows was fully compensated by increases in longer-term capital inflows and, consequently, that aggregate capital moving into Chile was not altered by this policy. Moreover, Valdés-Prieto and Soto (1998) argue that the controls only became effective in discouraging short-term flows after 1995, when its actual rate increased significantly. According to these authors, however, the aggregate volume of flows was not affected by the controls.

A traditional shortcoming of capital controls (on either outflows or inflows) is that it is relatively easy for investors to avoid them. Valdés-

Prieto and Soto (1998), for example, argue that Chile's controls have been subject to considerable evasion despite the authorities' efforts to close loopholes. Cowan and De Gregorio (1998) acknowledge this fact and construct a subjective index of the "power" of the controls. This index takes a value of one if there is no (or very little) evasion and a value of zero if there is complete evasion. According to their paper, this index reached its lowest value in the second quarter of 1995; by late 1997 and early 1998, this index had reached a value of 0.8.

Empirical results by Edwards (2000a, 2000b) and Edwards and Susmel (2003) show that during the second half of the 1990s—more specifically, during the East Asian and Russian crises—the existence of controls on inflows did not isolate Chile from external shocks. Indeed, these studies indicate that at that particular time, Chile was subject to greater "contagion" from the crisis countries—both "volatility contagion" and more traditional "mean contagion"—than other Latin American countries such as Argentina or Mexico, neither of which had controls on inflows.

Existing evidence also suggests that Chile's capital controls in the 1990s were not very successful in helping achieve the authorities' two other objectives: avoiding real exchange rate overvaluation and increasing monetary independence. As pointed out earlier, one of the fundamental purposes of Chile's restrictions on capital inflows was to reduce their volume and, therefore, their pressure on the real exchange rate. According to a paper coauthored by a senior official in the Ministry of Finance, "Growing concerns [about]… the real exchange rate pressure of capital inflows… led policymakers to introduce specific capital controls" (Cowan and De Gregorio, 1998, p. 3).

Valdés-Prieto and Soto (1996b) argue that the imposition of these restrictions in mid-1991 reflected the authorities' attempt to balance two policy objectives: reducing inflation and maintaining a competitive real exchange rate. According to these authors, by implementing these unremunerated reserve requirements, the authorities hoped to reduce—or at least delay—the real exchange rate appreciation effects of these flows, while also maintaining domestic interest rates that were significantly higher than international interest rates (corrected by expected devaluation). Higher domestic interest rates, in turn, were expected to help achieve the anti-inflationary objective.

The results from a number of empirical studies on the subject show that the imposition of capital controls was not successful in avoiding real exchange rate appreciation. Valdés-Prieto and Soto (1996a, 1996b), Cowan and De Gregorio (1998), Edwards (1999), and De Gregorio, Edwards, and Valdés (2000) all arrive at this conclusion using a variety of statistical and econometric techniques. For instance, Valdés-Prieto and Soto (1996b) conclude that "the unremunerated reserve requirement does not affect in any way the long-run level of the real exchange rate… In addition, … these reserve requirements have an insignificant effect on the real exchange rate in the short run" (p. 99). Intuitively, the reason for this result is simple: to the extent that the capital controls only affect the composition of flows, the effect of the aggregate flows on expenditure—and thus on the real exchange rate—will be approximately the same with or without controls.

Another fundamental objective of the capital controls policy implemented in Chile between 1991 and 1998 was to allow the country to maintain high domestic interest rates, in a context of a predetermined nominal exchange rate policy.[17] According to Cowan and De Gregorio (1998, p. 16), an important purpose of the controls policy was to "allow policymakers to rely on the domestic interest rate as the main instrument for reducing inflation." The authors go on to claim that "the reserve requirement has permitted maintaining the domestic interest rate above the international interest rate, without imposing excessive pressure on the exchange rate" (p. 16).

A number of authors use detailed econometric analyses to analyze whether the presence of controls allowed Chile's Central Bank to exercise a greater degree of control over domestic interest rates. De Gregorio, Edwards, and Valdés (2000), use vector autoregression (VAR) analysis to conclude that after the controls were imposed, the Central Bank had a greater ability to alter short-term interest rates in the very short run. Edwards (1998c) uses a state-space regression analysis to investigate whether the speed of convergence of domestic interest rates toward (properly adjusted) international rates had changed after the controls were imposed. The paper concludes that the restrictions on capital inflows imposed in 1991 did not have a significant effect on the level or dynamic behavior of either short- or long-term interest rates in Chile. These results suggest that, contrary to the authorities' goals, capital controls did not provide increased control over monetary policy. These findings are consistent with the results reported by Calvo and Mendoza (1999), who find that the decline in Chile's inflation in

17. During this period, Chile's nominal exchange rate regime was characterized by a crawling nominal exchange rate band. Although this is not a strict fixed exchange rate regime, in principle it may be subject to the restrictions associated with the so-called impossibility of the holy trinity.

1990–98 was largely unrelated to the authorities' attempts to target interest rates. According to Calvo and Mendoza's (1999) VAR analysis, the main forces behind Chile's disinflation were the real appreciation of the peso and (indirectly) a benign external environment, including positive terms of trade.

To sum up, the evidence discussed in this section, based on a large number of careful and detailed econometric studies, is mixed with respect to the effectiveness of Chile's controls on capital inflows. The controls of the 1970s and 1980s were unable to preclude a major crisis, and while the 1990s episode was more successful, it still had a number of limitations. Although the controls lengthened the maturity of inflows, they did not spare Chile from major contagion from the East Asian and Russian crises. Moreover, there is no evidence suggesting that these controls helped the authorities achieve their exchange rate and interest rate objectives.

2.2 Controls on Capital Outflows

Supporters of restricting capital mobility, such as Krugman (1999), Rodrik (1998), and Stiglitz (2002), argue that temporary controls on capital outflows will allow crises countries to lower interest rates and apply progrowth policies. According to this view, controlling capital outflows would also give crisis countries additional time to restructure their financial sector in an orderly fashion.[18] The controls should then be dismantled once the economy is back on its feet. The historical evidence, however, does not support the view that countries that tighten controls on capital outflows emerge from a crisis faster, or on better footing, than countries that don't. Two historical studies of over forty major currency crises in Latin America both find that countries that tightened controls after a major devaluation did not exhibit a better performance, in terms of economic growth, employment creation, or inflation, than those that did not.[19]

The 1980s debt crisis provides an illustration of the role of controls on capital outflows. Those Latin American countries that significantly stepped up controls on capital outflows—Argentina, Brazil, and Mexico, to mention just the largest—muddled through and experienced a long and painful decline in growth, high inflation and rampant

18. See Krugman (1999), for example.

19. See Edwards (1989) and Edwards and Santaella (1993) for details on these crisis episodes.

unemployment. Moreover, the stricter controls on outflows did not encourage the restructuring of the domestic economies, nor did they result in orderly reforms. The opposite happened, in fact. In all of these countries, politicians experimented with populist policies that ultimately deepened the crisis. Mexico nationalized the banking sector and expropriated dollar-denominated deposits. Argentina and Brazil created new currencies (namely, the austral and the cruzado, both of which were eventually eliminated, victims of hyperinflation) while at the same time controlling prices and expanding public expenditure. In Peru, tighter controls on outflows allowed the García administration to systematically erode the bases of a healthy and productive economy, as the country was rapidly consumed by a virtual civil war. In none of these countries were controls on capital outflows successful in slowing down capital flight.

Chile and Colombia offer an interesting contrast. Neither of these countries significantly tightened controls on capital outflows. Instead they made an effort to restructure their economies and to provide the right type of incentives for nationals to repatriate capital held abroad. Chile also implemented a modern bank supervisory system that greatly reduced domestic financial fragility. Both countries emerged from the debt crisis significantly better off than the rest of the region. They were, in fact, the only two large Latin American countries that experienced positive growth in per capita GDP and real wages during the so-called lost decade of the 1980s. Not surprisingly, then, in the mid-1980s Chile and Colombia were the only Latin American countries with an investment-grade rating from the major rating agencies such as Standard and Poor's and Moody's.

Recent experiences with currency crises also suggest that capital controls may give a false sense of security, encouraging complacent and careless behavior on behalf of policymakers and market participants. The Korean experience in the mid- and late 1990s is a case in point. Until just before the Korean currency crisis of 1997, international analysts and local policymakers believed that the existence of restrictions on capital mobility made Korea largely immune to a currency crisis—to the extent that, after giving the Korean banks and the stance of the Central Bank the next to worst ratings, Goldman Sachs argued, in its *Emerging Markets Biweekly,* that these indicators should be excluded from the computation of the overall vulnerability index because Korea had "a relatively closed capital account." Consequently, Goldman Sachs played down the extent of Korea's problems throughout most of 1997. Had Goldman

Sachs (correctly) recognized that capital restrictions cannot truly protect an economy from financial weaknesses, it would have clearly anticipated the Korean debacle, as it anticipated the Thai meltdown.

Controls on the free mobility of capital also gave a false sense of security to Brazilian policymakers in 1997–98. These authorities repeatedly argued that since short-term capital inflows were restricted, the Brazilian currency could not suffer the same fate as the Mexican peso. They were wrong. Once the collapse of the real became imminent, domestic and foreigner investors rushed to flee the country. More recently, the 2003 experience of Venezuela clearly demonstrates that the imposition of exchange and capital controls is not an effective way of dealing with major macroeconomic disequilibria. At best they help postpone (somewhat) the day of reckoning, and at worst they provide a distraction and ultimately amplify the magnitude of the eventual crisis.

Nobel Laureate Joe Stiglitz has been particularly critical of the opening of the capital account—to both outflows and inflows. He claims that the experiences of China and India, two countries that did not suffer a crisis, and of Malaysia, which did not follow the IMF's advice yet recovered quickly, support his views on the costs of opening up the capital account (Stiglitz, 2002). His argument is not overly persuasive, however, since there are many reasons why India and China have not faced a crisis, and attributing this to the presence of capital controls is overly simplistic, if not plainly wrong.

The case of Malaysia adds a different angle to the discussion. It recovered quickly after the 1997 crisis—although not as fast as South Korea—but it is not clear that the recovery was the result of the imposition of capital controls and the fixing of the exchange rate. Kaplan and Rodrik (2002) provide a detailed discussion of Malaysia's unorthodox reaction to the currency upheaval of 1997–98. The authors note that the imposition of capital controls by Malaysia in September 1998 was greeted with great skepticism by most analysts and observers. In particular, IMF officials and investment bank analysts argued that these controls—and the accompanying decisions to peg the exchange rate and lower domestic interest rates—would slow recovery and significantly reduce foreign direct investment into Malaysia. This latter (potential) effect of the controls was considered to be particularly devastating, as Malaysia has traditionally relied heavily on FDI. Kaplan and Rodrik argue that this general perception is incorrect, and that evidence based on appropriate econometric techniques suggests that Malaysia's unorthodox program yielded very positive results. Dornbusch

(2002) takes issue with this view, arguing that the good performance of the Malaysian economy in the post crisis period had little to do with the controls. In his opinion, a very friendly international environment, driven primarily by successive cuts in interest rates by the Federal Reserve, was the main force behind Malaysia's recovery of 1999–2000.

A full understanding of the Malaysian episode will require additional research. That said, Malaysia surprised many observers by tightening controls only temporarily; and once the economy had stabilized, the controls were lifted, just as Dr. Mahatir had originally announced. Historically, the temporary use of controls is quite rare. The norm is closer to what happened in Latin America during the 1980s debt crisis, when what was supposed to be a temporary tightening of controls became a long-term feature of the regional economies.

2.3 Capital Account Liberalization and the Sequencing of Reform

From a policy perspective, a particularly important question involves the speed and sequencing of liberalization. The key issues are how fast and at what point in the liberalization process should capital controls be eliminated and the capital account liberalized. Many critics of the reform process of the 1990s argue that in the 1990s many emerging countries liberalized their current account too fast and in the wrong sequence (Stiglitz, 2002).

The emphasis on speed and sequencing is not new in policy discussions. It has been addressed over and again since the beginning of the economics profession. Adam Smith, for example, argued in *The Wealth of Nations* that determining the appropriate sequencing was a difficult issue that involved, primarily, political considerations.[20] Smith supported gradualism on the grounds that cold-turkey liberalization would result in a significant increase in unemployment: "To open the colony trade all at once... might not only occasion some transitory inconvenience, but a great permanent loss... [T]he sudden loss of employment... might alone be felt very sensibly" (vol. 2, chap. 7, part 3, p. 120).

The issues of speed and sequencing were also central in analyses of how to design a reform strategy for the former communist countries. In discussing the problems faced by Czechoslovakia during the early period of its transition, Václav Klaus points out that one of the main

20. See the Cannan edition, book 4, chap. 7, part 3, p. 121.

problems was deciding on "sequencing as regards domestic institutional and price measures, on the one hand, and liberalization of foreign trade and rate of exchange, on the other" (Klaus, 1990, p. 18).

In the early 1980s the World Bank became interested in exploring issues related to the sequencing and speed of reform. Papers were commissioned, conferences were organized, and different country experiences were analyzed. As a result of this work, a consensus of sorts developed around five key points: trade liberalization should be gradual and buttressed with substantial foreign aid; an effort should be made to minimize the unemployment consequences of reform; countries with very high inflation should deal with fiscal imbalances very early in the reform process; financial reform requires the creation of modern supervisory and regulatory agencies; and the capital account should be liberalized at the very end of the process and only after the economy has successfully expanded its export sector. Not everyone agreed with all of these recommendations, but most people did. In particular, people at the IMF did not object to these general principles. Frenkel (1983) argues that the capital account should be opened toward the end of the reform process. It thus seems fair to say that by the late 1980s, the idea of gradualism and a sequencing in which the capital account came last had become part of the received wisdom.

Mundell (1995) also endorses this general view on sequencing: "Unfortunately… there are some negative externalities [of an early capital account liberalization]. One is that the borrowing goes into consumption rather than into investment, permitting the capital-importing country to live beyond its means… without any offset in future output with which to service the loans. Even if the liabilities are entirely in private hands, the government may feel compelled to transform the unrepayable debt into sovereign debt rather than allow execution of mortgages or other collateral" (p. 20).

Mundell thus acknowledges that the probability a government bailout of private borrowers constitutes a serious externality. Other analysts, such as Stiglitz (2002), fail to recognize this important point. Indeed, when criticizing the IMF's views on trade imbalances, Stiglitz argues—incorrectly, in my view—that the government should not worry if the private sector runs large deficits. Specifically, he states that a large private sector indebtedness to finance questionable investments "may be a problem for the creditor, but it is not a problem that the country's government—or the IMF—needs to worry about" (p. 200).

The received wisdom on the sequencing of capital account liberalization began to change in the 1990s, and economists at both the

IMF and the U.S. Treasury began to argue that an early opening of the capital account was desirable. This view was clearly stated by the late Manuel Guitián, then a senior official at the IMF, who in 1995 argued in favor of moving quickly towards capital account convertibility. Guitián's paper (suggestively titled "Capital Account Liberalization: Bringing Policy in Line with Reality") is one of the first written pieces that documents the IMF's change in view regarding sequencing and capital account convertibility. After discussing the evolution of international financial markets and expressing reservations about the sequencing recommendation to leave the capital account for last, Guitián summarizes his perspective as follows: "There does not seem to be an a priori reason why the two accounts [current and capital] could not be opened up simultaneously.… [A] strong case can be made in support of rapid and decisive liberalization in capital transactions" (Guitián, 1995, p. 85–86).

Partially as a result of this change in views on sequencing and capital account convertibility, a number of emerging and transition countries began to relax their controls on capital mobility in the second half of the 1990s. They tended to follow different strategies and paths. While some countries only relaxed bank lending, others only allowed long-term capital movements, and yet others—such as Chile—used market-based mechanisms to slow down the rate at which capital was flowing into the economy. Many countries, however, did not need any prodding by the IMF or the United States to open their capital account. Indonesia and Mexico, to mention two important cases, had a long tradition of free capital mobility, which preceded the events discussed in the 1990s, and they never had any intention of following a different policy.

In the aftermath of the crises of the 1990s, a number of authors, including economists at the multilateral institutions, began to reinvestigate the sequencing issue. The idea that an early liberalization may not be beneficial after all again gained some currency (see Eichengreen, 2003, for example). But agreeing that sequencing is important is not the same as saying that capital controls should never be lifted. A difficult and important policy issue that the critics of globalization do not really tackle is how and when to remove impediments to capital mobility. A first step in answering this question is determining the long-term consequences of capital mobility on economic performance. As Stiglitz acknowledges, this is a difficult question, and one about which we have limited evidence. Recent research using improved measures of the degree of openness of capital mobility suggests that a freer capital account has a positive effect on long-run growth in countries that have surpassed a certain stage in the development process and have strong institutions and domestic capital markets (see Edwards, 1999; IMF, 2003). The challenge for the transition and emerging countries is to rapidly implement the type of requirements—in terms of bank and capital market supervision—that would allow them to liberalize their capital accounts successfully.

3. Capital Account Restrictions and Vulnerability to Crises: Some New Results

As pointed out earlier, the main objectives of policies aimed at restricting capital mobility include reducing a country's vulnerability to external crises (Rodrik, 1998) and minimizing the damage once a crisis has occurred (Stiglitz, 2002). Although these arguments may seem plausible, efforts to investigate empirically whether this has indeed been the case have been limited. In this section, I report some new empirical work that addresses these issues.[21] The analysis focuses on the occurrence of current account reversals, a crisis-related phenomenon that tends to be very costly in terms of reduced growth. Specifically, I ask two questions that are directly related to the degree of openness of the capital account:

—To what extent does financial openness affect the probability of a country's being subject to a current account reversal? In other words, do restrictions on capital mobility reduce the probability of such occurrences?

—Does financial openness play a role in determining the effect of current account reversals on economic performance (that is, GDP growth)?

I also address the related issues of whether the existence of restrictions on capital mobility reduces the costs of external crises (that is, current account reversals) and whether the exchange rate regime affects the intensity with which reversals affect real activity.

I define a current account reversal as a reduction in the current account deficit of at least 4 percent of GDP in one year. An interesting question is how current account reversals relate to the sudden stop of capital inflows. To make a formal comparison, I define a sudden stop

21. This discussion is partially based on Edwards (2004a).

as an abrupt and major reduction in capital inflows to a country that has been receiving large volumes of foreign capital. In particular, a sudden stop occurs when net capital inflows have declined by at least 5 percent of GDP in one year (see Edwards, 2004b, for details).

Using a panel data set encompassing 157 countries, I find that the 1970–2001 period was characterized by a 5.8 percent incidence of sudden stops and an 11.8 percent incidence of reversals. Not surprisingly, these two phenomena are closely related, but the relation is less than perfect. Historically, many sudden stops were not related with reversal episodes. This indicates that many countries facing a sudden stop effectively used their international reserves to avoid an abrupt current account adjustment. At the same time, a number of countries went through major current account reversals without facing a sudden stop in inflows. Most countries in this group were not receiving large inflows to begin with, and they had financed their large deficits by drawing down international reserves (see Edwards, 2004b).

As shown in table 3, for the complete sample (2,228 observations), 46.9 percent of countries subjected to a sudden stop faced a current account reversal. At the same time, 22.9 percent of those with reversals also experienced a sudden stop in the same year. The joint incidence of reversals and sudden stops is highest in Africa, where approximately 62 percent of sudden stops happened at the same time as current account reversals, and almost 30 percent of reversals coincided with sudden stops. For every one of the regions, as well as for the complete sample, Pearson chi-squared tests for the independence of distributions have very small p values, indicating that although there are observed differences between these two phenomena, the two are statistically related. For the complete sample, the chi-squared statistic for the null hypothesis of independence of distributions has a value of 159.8. These results do not change significantly if I use different definitions of reversals and sudden stops or different configurations of lags and leads.

Table 3. Current Account Reversals and Sudden Stops

A. All countries

Presence of reversal	*No sudden stop*	*Sudden stop*	*Total*
No reversal (no. episodes)	1892	69	1961
	96.5	3.5	100
	90.2	53.1	88.0
Reversal (no. episodes)	206	61	267
	77.1	22.9	100
	9.8	46.9	12.0
Total (no. episodes)	2098	130	2228
	94.2	5.8	100
	100	100	100
Summary statistic			
Pearson χ^2 (1)	159.8		
p value	0.0		

B. Industrial countries

Presence of reversal	*No sudden stop*	*Sudden stop*	*Total*
No reversal (no. episodes)	539	18	557
	96.8	3.2	100
	98.2	81.8	97.6
Reversal (no. episodes)	10	4	14
	71.4	28.6	100
	1.8	18.2	2.5
Total (no. episodes)	549	22	571
	96.2	3.8	100
	100	100	100
Summary statistic			
Pearson χ^2 (1)	21.1		
p value	0.0		

C. Latin America and Caribbean

Presence of reversal	*No sudden stop*	*Sudden stop*	*Total*
No reversal (no. episodes)	578	23	601
	96.2	3.8	100
	87.2	44.2	84.1
Reversal (no. episodes)	85	29	114
	74.6	25.4	100
	12.8	55.8	15.9
Total (no. episodes)	663	52	715
	92.7	7.3	100
	100	100	100
Summary statistic			
Pearson χ^2 (1)	18.4		
p value	0.0		

Table 3. (continued)

D. Asia			
Presence of reversal	*No sudden stop*	*Sudden stop*	*Total*
No reversal (no. episodes)	294	12	306
	96.1	3.9	100
	87.5	48.0	84.8
Reversal (no. episodes)	42	13	55
	76.4	23.6	100
	12.5	52.0	15.2
Total (no. episodes)	336	25	361
	93.1	6.9	100
	100	100	100
Summary statistic			
Pearson χ^2 (1)	9.6		
p value	0.002		

E. Africa			
Presence of reversal	*No sudden stop*	*Sudden stop*	*Total*
No reversal (no. episodes)	579	21	600
	96.5	3.5	100
	85.8	37.5	82.1
Reversal (no. episodes)	96	35	131
	73.3	26.7	100
	14.2	62.5	17.9
Total (no. episodes)	675	56	731
	92.3	7.7	100
	100	100	100
Summary statistic			
Pearson χ^2 (1)	60.6		
p value	0.0		

F. Middle East			
Presence of reversal	*No sudden stop*	*Sudden stop*	*Total*
No reversal (no. episodes)	193	12	205
	94.2	5.8	100
	87.7	50.0	84.0
Reversal (no. episodes)	27	12	39
	69.2	30.8	100
	12.3	50.0	16.0
Total (no. episodes)	220	24	244
	90.2	9.8	100
	100	100	100
Summary statistic			
Pearson χ^2 (1)	22.4		
p value	0.0		

Source: Author's elaboration.

In a number of models, the costs of foreign shocks (including sudden stops and current account reversals) are inversely proportional to the country's degree of openness. In Mundell-Fleming-type models, the expenditure-reducing effort, for any given level of expenditure switching, is inversely proportional to the marginal propensity to import. In these models, adjustment costs are also inversely proportional to the degree of financial integration. Countries with a higher degree of financial openness will require a smaller reduction in aggregate income to accommodate external shocks than countries with a lower degree of financial integration (Frenkel and Razin, 1987). Calvo, Izquierdo, and Mejía (2004) develop a model in which sudden stops result in abrupt current account reversals and major real exchange rate depreciations. Depreciations, in turn, are contractionary, with the extent of the contraction depending inversely on the degree of trade openness of the economy. The authors argue that sudden stops and current account reversals will have a greater impact in closed economies, such as Argentina, than in relatively open ones, such as Chile.

Previous empirical works on the effects of current account reversals on real economic performance reach different conclusions. Milesi-Ferretti and Razin (2000), for example, conclude that reversals "are not systematically associated with a growth slowdown" (p. 303). Edwards (2002), on the other hand, uses dynamic panel regressions and concludes that major current account reversals has a negative effect on investment and on GDP per capita growth, even after controlling for investment. Neither of these papers, however, analyzes the interaction between either openness or the exchange rate regime and the costs of current account reversals.

3.1 An Empirical Model

I use a "treatment effects" model to estimate jointly an equation on real GDP growth and a probit equation on the probability of a current account reversal.

$$g_j^* = \phi + \mathbf{x}_j\beta + \omega_j \tag{2}$$

$$\Delta g_{t,j} = \lambda\left(g_j^* - g_{t-1,j}\right) + \varphi v_{t,j} + \gamma\delta_{t,j} + \theta\left(\delta_{t,j}\text{OPENNESS}_{t,j}\right) + \xi_{t,j} \tag{3}$$

$$\delta_{t,j} = \begin{cases} 1 & \text{if } \delta_{t,j}^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

$$\delta^{*}_{t,j} = \mathbf{w}_{t,j}\alpha + \varepsilon_{t,j} \tag{5}$$

Equation (2) is a long-run growth equation, in which g_j* is long-run real per capita GDP growth in country *j*; $\mathbf{x}_j$ is a vector of covariates that capture the role of traditional determinants of growth, and w_j is an error term. Equation (3) is a growth dynamics equation, in which $(g_j^* - g_{t-1,j})$ is a partial adjustment term (the growth gap), $v_{t,j}$ is a terms-of-trade shock, and $\delta_{t,j}$ is a dummy variable (that is, the treatment variable) that takes a value of one if country *j* in period *t* experienced a current account reversal, and zero if the country did not experience a reversal. Thus, δ is the parameter of interest: the effect of the treatment on the outcome. Finally, ($\delta_{t,j}$ OPENNESS$_{t,j}$) is a variable that interacts $\delta_{t,j}$ with a measure of openness. Whether the country experiences a current account reversal is assumed to be the result of an unobserved latent variable, $\delta_{t,j}$*, in equation (4); this variable, in turn, is assumed to depend on vector $\mathbf{w}_{t,j}$. Some of the variables in $\mathbf{w}_{t,j}$ may be included in $\mathbf{x}_{t,j}$. Exclusionary restrictions are imposed for identification purposes Finally, β and α are parameter vectors, and $x_{t,j}$ and $e_{t,j}$ are error terms that are assumed to be bivariate normal, with a zero mean and a covariance matrix:

$$\begin{pmatrix} \sigma & \varsigma \\ \varsigma & 1 \end{pmatrix}. \tag{6}$$

I use a two-step estimation procedure. Equation (2) is estimated using data for long-term averages and feasible least squares. Fitted values of long-term growth are used for g_j* in equation (3). Equations (3) and (5) are then estimated jointly. The estimation of equation (3) includes terms that interact the dummy variable $\delta_{t,k}$ with two openness variables—one for trade and one for financial openness. Trade openness is defined as the ratio of imports plus exports to GDP. Financial openness is measured using the new index discussed above, which combines the Quinn (2003) index and the Mody and Murshid (2002) index on capital mobility. This new index ranges from 1 to 100, with higher values denoting a higher degree of financial integration. Thus, countries with stricter capital controls have a lower value of this index. Since I am interested in understanding the role of financial openness in the probability of reversals, one of the variables in $\mathbf{w}_{t,j}$ in equation (4) is the index of financial integration described above.

In the long-run growth equation (equation (2)), the dependent variable is real GDP growth per capita. The following covariates were included: the log of initial GDP per capita; the investment ratio; the coverage of secondary education; an index of the economy's degree of openness; the ratio of government consumption to GDP; and regional dummies. Some specifications also include an index for the exchange rate regime. Results from the estimation of equation (2) are not reported due to space constraints.

In growth equation (3), $v_{t,j}$ is the change in the terms of trade, and $d_{t,j}$ is the current account reversals dummy. As stated, I also include the current account reversal dummy interacted with the trade openness variable and with the financial openness index. If reversals have a negative impact on short-term growth, the coefficient of the reversals dummy will be significantly negative. If this effect is inversely proportional to the country's degree of openness, the coefficients of the interaction between reversals and openness should be significantly positive.

In specifying equation (5), I followed the empirical literature on crises. I included the following covariates (all lagged one period): the ratio of the current account deficit to GDP; the external debt to GDP; net international reserves to GDP; the share of short-term external debt; the relative occurrence of sudden stops in the country's region; growth of domestic credit; the log of initial per capita GDP; an index of financial integration; and country-specific dummies.

3.2 Basic Results

Table 4 summarizes the basic results obtained from the estimation of a number of treatment models for GDP growth dynamics. The table contains two panels. The upper panel includes the results from the growth equation; the lower panel contains the estimates for the "treatment equation," or probit equation on the probability of experiencing a current account reversal. As pointed out above, the treatment observations correspond to current account reversal episodes. Table 4 also includes the estimated coefficient of the hazard lambda, as well as the estimated elements of the variance-covariance matrix (equation (5) above). The first three equations are for emerging markets. The last equation (column 4) is for the complete sample of emerging and industrial countries. I discuss first the results from the probit equations on the probability of reversals. I then focus on the results from the dynamics of growth equations.

Table 4. Current Account Reversals, Openness, and Growth[a]

Variable	*(1)*	*(2)*	*(3)*	*(4)*
Growth equation				
Growth gap	0.843**	0.843**	0.840**	0.834**
	(33.1)	(33.1)	(32.8)	(33.1)
Change in terms of trade	0.062**	0.061**	0.061**	0.066**
	(8.51)	(8.46)	(8.45)	(8.51)
Reversal	–6.025	–5.087	–2.710**	–5.722
	(5.66)	(3.86)	(2.32)	(6.64)
Reversal*trade openness	0.032**	0.034**		0.023**
	(3.66)	(3.78)		(3.08)
Reversal*financial openness		–0.024	–0.014	
		(1.21)	(0.74)	
Treatment equation				
Current acc. deficit to GDP (–1)	0.114**	0.114**	0.114**	0.122**
	(9.82)	(9.82)	(9.82)	(10.78)
External debt to GDP (–1)	0.004**	0.004**	0.004**	
	(2.30)	(2.30)	(2.30)	
Net int. reserves to GDP (–1)	–0.148*	–0.148*	–0.148*	–0.188*
	(1.78)	(1.76)	(1.76)	(2.38)
Short-term external debt to external debt (–1)	0.001	0.001	0.001	
	(0.42)	(0.42)	(0.42)	
Incidence of reversals in region	1.522**	1.524**	1.524**	1.556**
	(2.50)	(2.50)	(2.50)	(2.70)
Domestic credit growth (–1)	0.002	0.002	0.002	0.002*
	(1.32)	(1.32)	(1.32)	(1.78)
Log initial GDP per capita	–1.743**	–1.743**	–1.743**	–0.845**
	(7.51)	(7.51)	(7.51)	(3.71)
Financial openness (–1)	–0.007	–0.007	–0.007	–0.009**
	(1.54)	(1.55)	(1.55)	(2.09)
Hazard l	1.192**	1.232**	1.082**	1.314**
	(2.49)	(2.57)	(2.25)	(3.23)
Variance-covariance matrix				
ρ	0.284	0.347	0.257	0.346
σ	4.611	4.606	4.208	3.804
Summary statistic				
Wald χ^2	1,634.1	1,174.2	1,221.9	1,916.9
No. observations	1,176	1,174	1,174	1,561

Source: Author's calculations.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent.

a. The estimation method is a treatment effects model with two-step estimates. The treatment equation is a probit equation on the probability of experiencing a current account reversal; treatment observations correspond to current account reversal episodes. The sample used in the columns one through three is emerging markets; in column 4, it is for the complete sample of emerging and industrial countries. Variables denoted (–1) are lagged one period. Country-specific and year dummies are included but not reported. Absolute value of z statistics are in parentheses.

The probit estimates are presented in the lower panel of Table 4. The results are similar across models: most coefficients have the expected signs and are statistically significant at conventional levels. These results indicate that the probability of experiencing a reversal is higher for countries with a large (lagged) current account deficit, a high external debt ratio, a rapid rate of growth of domestic credit, lower initial GDP, and a high occurrence of sudden stops in their region. Countries that have a higher level of net international reserves have a lower probability of experiencing a reversal. The coefficients of the short-term debt have the expected sign, but they tend not to be significant. The coefficient of the financial openness index is negative in all regressions, and it is significantly negative in column 4 for the complete sample. This provides some (weak) evidence suggesting that countries with a higher degree of financial openness have a lower probability of facing a current account reversal. That is, contrary to what has been argued by critics of globalization and by supporters of restricting capital mobility, these results suggest that the presence of capital account restrictions does not reduce the probability of an external crisis. These results are robust to the sample used, as well as to the specification of the probit equation. A possible explanation is that the public finds way to circumvent the restrictions. Another possibility is that the authorities in countries with capital controls may become overconfident and tend to implement riskier macroeconomic policies.

The results from the estimation of the growth dynamics equation are reported in the top panel. The coefficients of the growth gap and the terms of trade have the expected signs and are significant. More importantly, the coefficients of the current account reversal dummy are always significantly negative, and the coefficient of the term that interacts trade openness and reversals is always significantly positive. In columns 2 and 3, the estimated coefficient of the variable that interacts reversals and financial openness is negative but not significant. All in all, these results suggest that financial openness has no effect on the way in which reversals affect growth. That is, in contrast with the claims of supporters of capital controls, there is no evidence supporting the view that countries that restrict capital mobility face a lower cost of crises—or, more specifically, of current account reversals— than countries that allow for greater capital mobility.

The interaction between the current account reversals dummy and the trade openness variable is particularly interesting. In all specifications in the table, the coefficient of this interactive variable is positive and significant at conventional levels. This means that the effects of a current account reversal on short-term growth depend significantly on the degree of trade openness of the economy. This result can be illustrated for the case of column 1:[22]

$$\text{Growth effects of reversals} = -6.025 + 0.032\ \text{TRADE\_OPENNESS}.$$

The trade openness variable varies significantly across countries. Its mean is 65 percent, its standard deviation is 35 percent, and its median is 67.4 percent. The first decile is 28.7 percent, and the ninth decile is 130.7 percent. For a country with a degree of openness equal to the mean, the point estimate of the effect of a reversal on GDP growth (relative to trend) is: –3.945 percent (–6.025 + 0.032 x 65 = –3.945). If the country's degree of openness is equal to the first decile, the effect of a reversal on growth is more negative, –5.11 percent. If the country is very open to trade (with a degree of openness corresponding to the ninth decile), the effect of a reversal on growth is much smaller, at –1.84 percent.

An important question is whether the effects of current account reversals on growth dynamics depend on the exchange rate regime. To address this issue, I divided the sample into four alternative de facto regimes: hard peg; pegged, intermediate, and flexible (see Levy Yeyati and Sturzenegger, 2003, for the classification). I then compared the estimates of both the reversals treatment dummy and the term that interacts reversals and trade openness. The results may be summarized as follows: the estimated coefficient of reversals (*z* statistic) for pegged regimes was –6.573 (–4.43); for flexible rates it was positive and not significant, at 0.373 (1.09); and the interactive term was 0.041 (3.43) for pegged and –0.044 (–1.01) for flexible regimes. A chi-squared test indicates that these differences in coefficients across regimes are significant. These results support the idea that flexible exchange rates act as shock absorbers, allowing countries to accommodate external shocks, including current account reversals.

To sum up, econometric analysis reported in this section suggests that restricting capital mobility does not reduce the probability of experiencing a current account reversal. Current account reversals, in turn, have had a negative effect on real growth that goes beyond their direct effect on investment. The regression analysis indicates that the negative effects of current account reversals on growth depend on the country's degree of trade openness: more open countries will

22. I am ignoring the other coefficients from this equation. See table 4 for details.

suffer less—in terms of lower growth relative to trend—than countries with a lower degree of trade openness. On the other hand, the degree of financial openness does not appear to be related to the intensity with which reversals affect real economic performance. The empirical analysis also suggests that countries with more flexible exchange rate regimes are better able to accommodate shocks stemming from a reversal than countries with more rigid exchange rate regimes. In interpreting the findings reported in this paper, it is important to keep in mind that measuring financial integration is far from easy (Quinn, 2003). Further work on the subject should aim at improving indexes of financial integration and capital account restrictions.

4. Concluding Remarks

In this paper I have reviewed both the policy arguments used to justify restricting capital mobility and the extent to which these policy objectives have been achieved. I evaluated the effectiveness of controls on inflows and controls on outflows, and I discussed arguments related to the appropriate sequencing of economic liberalization. A central aspect of the paper has been the estimation of an empirical model of current account reversals and economic performance. Overall, the analysis presented in this paper suggests that policies aiming at capital controls have been less effective—in terms of helping achieve their objectives—than their supporters claim. I have argued that the merits of Chilean-style controls on capital inflows are somewhat exaggerated, based on evidence that the effectiveness of this tool was limited. Chile itself abolished the controls more than five years ago, and the authorities have no intention of reinstating them in the future. I also argued that historically the experience with controls on outflows has tended to be negative: they don't help to reestablish growth, they encourage black markets and corruption, and they create a false sense of security. Malaysia in the 1990s is, perhaps, an exception to this proposition. The views on the evidence are contradictory, and a definitive evaluation of effectiveness of these controls will have to await further details. What is clear, however, is that Malaysia presents a unique set of historical and political circumstances. It is highly unlikely that its experience—most notably, the lifting of controls after one year—would be replicated in other countries. The argument that capital controls should be abolished once other reforms have been undertaken has merits. In particular, historical and statistical evidence suggests that implementing a modern bank supervisory system before lifting capital controls is crucial. However, the fact that there is an adequate and preferred sequencing does not mean that controls on capital mobility should never be lifted.

Finally, as documented by Forbes (2003), Desai, Foley, and Hines (2004), and Gallego and Hernández (2003), restricting capital mobility also has important costs. Once these are introduced into the analysis, the attractiveness of policies that control capital mobility declines. At the end of the day, however, the final result on the net benefits (or costs) of this type of policy will be country specific: in some countries they may play a positive transitional role, while in others they are likely to have net costs.

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Sovereign Debt, Volatility, and Insurance

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International capital inflows should, in theory, enable emerging market economies to reduce the volatility of private and public consumption in the presence of income volatility, in addition to allowing foreign savings to finance domestic capital accumulation. Access to international financial markets should provide opportunities for the domestic private sector and government to diversify against aggregate country-specific income risk. In practice, international capital flows to emerging markets are themselves volatile and sometimes propagate external shocks to domestic consumption and investment or exacerbate domestic shocks. Higher levels of external debt increase the exposure of developing countries to world output and interest rate fluctuations and to the possibility of sudden capital flow reversals that may be poorly explained by country fundamentals.

This comparison between theory and experience of borrowing by emerging market economies motivates the arguments made below. The comparison suggests two questions: can the volatility associated with external debt be reduced, and can capital inflows be managed to reduce domestic volatility? These are really a single question that is addressed directly in models of foreign borrowing with country-specific income shocks and a risk-sharing motive.

Another feature of international borrowing by emerging market economies is the prospect of default followed by the restructuring of public sector external liabilities, which can include publicly guaranteed private foreign debt. Debt crises, defaults, and delayed debt

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restructurings are all very costly and are associated with income losses for debtor countries. Debt renegotiation may be seen as a means through which international debt contracts are revealed to be implicit state-contingent contracts that allow the sharing of country-specific risks across borders. In this sense, modeling sovereign debt renegotiation is a starting point for understanding the role of debt contracts and debt restructurings in international risk sharing. It also raises the concerns that this is a very costly way, in practice, to share risk and that welfare-improving innovations in international financial contracting may be beneficial and possible.

The high costs of capital account crises, sovereign default, and debt renegotiation has generated renewed calls for institutional innovation or market reform in recent years. Easing debt restructuring has dominated the agenda because external debt burdens contribute to domestic macroeconomic and financial volatility and prolonged restructuring postpones recovery. Making debt restructuring easier, however, raises the possibility that debtor default will become more probable as it becomes less costly. Although easier renegotiation may be welfare enhancing ex post, it may raise debtor moral hazard and reduce welfare ex ante by inhibiting capital flows to emerging markets. This conflict needs to be evaluated in formal models of sovereign debt. The first part of this paper considers how debt renegotiation in equilibrium models of sovereign borrowing affects welfare and capital inflows. It discusses two major variants of equilibrium models of foreign lending subject to sovereign default and explains how renegotiation enhances welfare in these models. This discussion abstracts from the costs of renegotiation, but it allows the costs of sovereign default to be endogenous to renegotiation.

The standard consumption-smoothing model serves as a benchmark for considering how to insure debtor economies against domestic and foreign shocks. Two versions of this model are considered, one with perfect information and one with private debtor information. The second can represent the sovereign's private information about its political will or capacity to repay foreign creditors or private information about the policies it is pursuing or expects to pursue. In the model, the debtor government simply has private information about country fundamentals. Equilibrium capital flows, implicit contracts, and the interpretation in terms of debt contracts and renegotiations are summarized in both versions.

Access to international financial flows serves to smooth domestic absorption against income shocks in these models. This is achieved in the perfect information case by state-contingent contracts, which are reinterpreted in terms of debt renegotiation. Implied renegotiation is continuous. In the private information case, conventional bond contracts implement the equilibrium, with default and renegotiation occurring in equilibrium only for high debt levels and poor income realizations. In both models, implementation using gross domestic product (GDP) or commodity-price-indexed contracts is considered. I argue that contractual derivatives may be combined with standard bond contracts to implement smoothing outcomes. In the case of private debtor information, delegated monitors might be able to observe and monitor fundamentals whereas dispersed bondholders cannot. The paper argues that derivatives held by sophisticated creditors who monitor the debtor can facilitate the successful issuance of conventional bonds to other investors that will not need to be renegotiated in poor outcomes. The derivative contract is akin to a combination of interest and default swaps.

The volatility that foreign interest payments create for emerging market governments is significant, as suggested most recently by Borensztein and Mauro (2004). The procyclicality of capital flows and public finance in emerging markets, as carefully documented by Kaminsky, Reinhart, and Végh (2005), is probably not an efficient outcome. Proposals to create GDP-indexed securities are naturally supported by the arguments in this paper. The provisional implication of this paper, however, is that achieving the needed state contingency can be replicated using standard bonds and derivative instruments rather than combining roles in a single financial instrument. This can allow investors of differing monitoring capacities, risk attitudes, and needs to choose between low-risk bonds and risky derivatives.

The paper is organized as follows. Section 1 discusses sovereign debt renegotiation and summarizes the perfect information consumption-smoothing model. Section 2 discusses the implementation of implicit contracts through renegotiation and through GDP-indexed or commodity-price-indexed securities. Sections 3 and 4 discuss the imperfect information model and its implications for contractual innovation, respectively. Section 5 briefly returns to the recent debate over contractual innovation to ease debt restructuring, and section 6 concludes. A caveat is in order. The paper sketches properties and implications of the two models without complete analysis or formal proofs. The complete analysis of the first is in the literature, but the second awaits a full analysis.

1. Sovereign Debt Renegotiation and Welfare

The gains from access to international capital markets are well known. These are the traditional gains from international risk sharing and allocating savings to the most productive investment opportunities globally. Respect for the sovereign immunity of nations is one of the major impediments to international capital flows and convergence of the net returns to savings across borders. Immunity from interference with a debtor nation's sovereignty inhibits the enforcement of contracts between either sovereign or nonsovereign borrowers and foreign creditors. It rules out direct enforcement of contracts involving sovereigns, hence reducing the ability of governments to commit to fulfill the terms of contracts to which they are a party. The literature on foreign debt has long identified sovereignty as a source of market incompleteness in international financial trade. Indirect sanctions—for example, restrictions on future access to credit or interferences with commodity trade—are identified as means of enforcing debt repayment by sovereign borrowers or nonsovereign borrowers subject to foreign legal jurisdiction.

The conventional modeling framework for sovereign borrowing imposes the constraint that the debtor pays only as much as is in its enlightened self-interest to pay, recognizing the consequences of default. The observation that willingness to pay restricts international capital flows (as articulated by Wallich, 1943, for example) was incorporated in formal models by Eaton and Gersovitz (1981).[1] In a riskless environment, willingness to pay leads to an upper bound on outstanding country debt. With shocks to country resources, preferences, or world markets, lending to sovereigns becomes risky for both creditors and debtors. Creditors face uncertain repayments as the debt service that borrowers are willing to repay fluctuates with shocks, sharing the adverse shocks realized by borrowers. Given external indebtedness, a borrower minimizes the cost of a drop in domestic production or a foreign price or interest rate shock by choosing between repayment and default. The risk of default is a reflection of the impact of foreign indebtedness on the cost of volatility for the debtor country.

Simple models with exogenous penalties for default are useful for fixing ideas. If the penalty for default is fixed, with a cost P in terms of

1. The survey by Eaton, Gersovitz, and Stiglitz (1986) gives a full overview of the modern approach to modeling country risk.

debtor income each period, then the borrower will service its debt if rD is less than or equal to P. We suppose the debtor government seeks to maximize the objective

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} u(c_s), \tag{1}$$

where aggregate consumption, c_s, equals an exogenous endowment, y, less the current repayment or the penalty. For a discount rate higher than the international interest rate, r, the equilibrium debt will equal the present value of the punishments, P. The loan is made at the outset. In this case, creditors receive nothing from any additional lending. The assumption that default results in the penalty P only in the period in which the payment was not received is consistent with the bargaining model of Bulow and Rogoff (1989a) which endogenizes the equilibrium cost of trade sanctions.

For volatile GDP, y is stochastic and there are incentives to renegotiate debt repayments. For example, the penalty P can be the gains from trade, measured in units of a perishable exportable good, that are lost if trade sanctions are imposed in a given period. With stochastic penalties, default on a standard bond contract occurs whenever $P < rD$. Both creditors and the debtor forgo sharing the gains from trade if a default is declared and punished. However, there are gains from state-contingent repayments, which might be achieved through ex post renegotiation of repayments. If the stochastic penalty P equals stochastic repayments, then equilibrium lending and repayment are efficient subject to the constraints imposed by the inability of debtors to commit to repay more than P. Suppose that P is distributed uniformly over the interval,

$$\left[\underline{P}, \bar{P}\right],$$

independently for each period. Total lending under state-contingent repayment is given by

$$D = \frac{1+r}{r}\left(\frac{\underline{P}+\bar{P}}{2}\right). \tag{2}$$

Restricting contracts to standard debt contracts that are repaid with certainty restricts initial lending to equal the present value of the smallest realization of P, rather than the expected present value of the sequence of penalties. In the example, total lending equals

$$\frac{1+r}{r}\underline{P}.$$

Similarly, allowing no renegotiation restricts repayments to equal rD when this is less than P and zero otherwise. Total lending is then given by

$$D = \frac{1+r}{r}\left(\frac{\bar{P} - rD}{\bar{P} - \underline{P}}\right). \tag{3}$$

If debt repayments are renegotiable, then $rD = \bar{P}$ and renegotiation occurs with probability one, but welfare is maximized subject to the sovereign immunity constraint.

This simple model illustrates two points. First, an increase in the penalty for default increases potential capital flows and gains from intertemporal trade if sovereign immunity is a binding constraint on foreign lending. Second, if renegotiation of repayments replicates state-contingent repayments, allowing renegotiation will increase welfare. This is true in an economy with symmetric information between debtors and creditors. Renegotiation increases the probability of default under a conventional debt contract but increases lending and welfare. Below, I discuss at length a model in which the incentives to repay are endogenous to renegotiation opportunities.

If the debtor government guarantees the foreign debt of private borrowers but the sanctions for default are shared, then the government needs to restrict domestic foreign borrowing to maximize its welfare objective. At the margin, the private cost of borrowing will be less than the social cost because private borrowing increases the expected costs of default. Similarly, as demonstrated by Kletzer (1984), when foreign lenders cannot observe the total borrowing by the government or guaranteed by the government, indebtedness is higher than is optimal for the government. The sovereign needs to monitor its increase in liabilities, and lenders have an incentive to coordinate lending by announcing loans and terms.

A consumption-smoothing model with stochastic debtor resources is used to analyze debt renegotiation further. The consumption-smoothing motive generates gains from introducing state-contingent payments and offers a natural way for future credit access to provide incentives for repayment. The model abstracts from capital accumulation, hence storage or borrowing for growth, but productive capital and investment can be added to such models without changing the qualitative implications for debt restructuring and renegotiation.

The sovereign's objective is given by equation 1, where consumption can be taken as the aggregate consumption of residents, government consumption, or recurrent public goods spending. For the first interpretation, all external debt can be government liabilities, under explicit or implicit guarantees of subnational public debt and private debt. In the other interpretations, the only liabilities of the sovereign might be government debt used to finance primary deficits of the public sector. The interpretation does not matter as long as $u(c)$ is strictly concave and increasing. The consumption-smoothing model is analytically equivalent to a tax-smoothing model. Sovereign immunity is represented by the capacity of the sovereign to abandon foreign capital markets. It is not required to borrow, and the national endowment cannot be seized or otherwise impaired by foreign creditors. Therefore, the sovereign can always choose permanent loan autarchy, so that welfare in any equilibrium is bounded from below by the utility of permanent autarchy,

$$U_t = u(c_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(c_s) \geq u(y_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(y_s) , \tag{4}$$

where the endowment y_s is stochastic and nonstorable. This constraint is a self-enforcement constraint on equilibrium, familiar from Thomas and Worrall (1988), Kocherlakota (1996), Kletzer and Wright (2000), and Kehoe and Perri (2002). For simplicity, the endowment can be thought of as generated by an independent and identically distributed (i.i.d.) process, but the arguments apply when y follows a Markov chain.

Following Kletzer and Wright (2000), I introduce self-enforcement constraints for risk-neutral potential creditors, as well. Given the assumption of risk-neutral counterparties to contracts, the gains from intertemporal trade are generated in the simplest analytical way that focuses attention on the idiosyncratic risk of the sovereign borrower rather than market risk. The creditor's objective is given by

$$U_t^c = \tau_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} \tau_s \geq 0 , \tag{5}$$

where τ_s is the net transfer received by the creditor from the debtor on date s. For a single creditor, $\tau_s = y_s - c_s$. Kletzer and Wright (2000) make several points. The self-enforcement constraint for the creditor is important and represents the creditor's ability to simply quit dealing with the borrower. The lender does not need to provide a new net resource transfer (negative τ) unless it raises its present value in expectation. This contrasts with the case of pure insurance, in which an insurer may be required to make an indemnity payment that exceeds the expected present value of insuring the insuree in the future. It corresponds, however, to a bondholder or bank that chooses whether to make a net payment to a borrower in anticipation of future repayments but that can always decide to buy a different asset. That is, the lender voluntarily makes new net resource transfers to the borrower, in contrast with rolling over unpaid debt service.

Kletzer and Wright (2000) illustrate punishments that satisfy an important criterion. The punishments are renegotiation-proof in a repeated game of consumption smoothing and are not permanent exclusions from the credit market (which are not credible under renegotiation). The punishments can be interpreted as short-lived moratoria on lending which are credible in the presence of potential renegotiation and entry by new lenders, although they also lead to sudden increases in net capital outflows from the debtor country. An important result is that the constrained efficient equilibria that can be supported by the threat of permanent loan autarchy are sustainable using credible punishments. This means that the efficient outcomes of intertemporal trade can be found by maximizing

$$U_0 = u(c_0) + E_0 \sum_{t=1}^{\infty} \beta^t u(c_t), \tag{6}$$

with respect to the entire consumption plan, $\{c_t\}$, subject to

$$y_0 - c_0 + E_0 \sum_{t=1}^{\infty} \beta^t (y_t - c_t) \geq U_0^c, \tag{7}$$

for any feasible initial creditor surplus, U_0^c, and the self-enforcement constraints given by equations 4 and 5, which hold for all t. Thomas and Worrall (1988) solve for these equilibria and show that consumption smoothing is incomplete, in general. Complete consumption smoothing in the steady state is possible for a high enough discount factor, β, near unity, and no credit transactions are feasible for a low enough discount factor, but greater than zero. In between, the debtor's consumption follows a Markov chain, where consumption in period t is an increasing function of previous consumption and current resources, $c_t(c_{t-1}, y_t)$. Consumption is nondecreasing in debtor resources, but it is not i.i.d. (even if resources are) when consumption is incompletely smoothed in equilibrium. Also, to meet the self-enforcement constraints of each side of the market, consumption will be higher than the endowment in low resource states and below it in high states.

The self-enforcement constraints on international credit transactions in this model imply that the maximal net amount, $\bar{\tau}_t$, that the debtor will repay with the endowment, y_t, is given by

$$u(y_t) - u(y_t - \bar{\tau}_t) = E_t \sum_{s=t-1}^{\infty} \beta^{s-t} \left[u(c_s) - u(y_s) \right], \tag{8}$$

where the right-hand side of this equality represents the equilibrium gains from access to international consumption smoothing for the sovereign. This is nonnegative and provides the motivation for debtor repayment. In equilibrium, the debtor's consumption is greater than the endowment in some states, so that these gains are positive. This means that $\bar{\tau}_t$ is not paid by the debtor in all states at all dates; indeed, the actual net payment, τ_t, will be negative, indicating a net resource inflow in many events in equilibrium. After no point can the debtor repay on net with certainty. Otherwise, the debtor would not gain by repaying and would opt for permanent autarchy. However, risk aversion implies that the debtor can repay in expectation.

The efficient solution maximizes these gains subject to the self-enforcement constraints. Therefore, any increase in the gains from trade increases the amount that the debtor will repay. Eliminating state-contingent repayments reduces the gains from trade, thereby reducing the incentives to repay. An interpretation of debt renegotiation is that the standard debt contract is a guide for an implicit state-contingent contract. The implicit contract is the state-contingent contract that supports the constrained efficient equilibrium. In this interpretation, renegotiation in a long-term debtor-creditor relationship implements the state-contingent contract. The opportunity for renegotiation in this perfect-information economy increases the gains from trade and thus increases the incentives for debtor repayment in high endowment states.

Two complications might reverse this conclusion. The first is the presence of asymmetric information between the sovereign debtor and foreign creditors. For example, if debtor resources depend on unobserved debtor policies, then creditors face debtor moral hazard. The general model is still informative, however. In models of risk sharing under repeated moral hazard, partial risk sharing is an equilibrium outcome, and reported low outputs lead to both lower current consumption and lower future surplus for the debtor in constrained efficient equilibrium. This just parallels the equilibrium under perfect information with incomplete risk sharing stemming from self-enforcement constraints. Since an implicit state-contingent contract supports the constrained optimum, renegotiation of a simple debt contract in a long-term debtor-creditor relationship will be welfare improving. Information asymmetries matter, but debtor moral hazard may not mean that easing renegotiation reduces welfare and capital flows.

The second potential complication is that creditor rights across different creditors or classes of creditors may not be well defined in debt renegotiations. One example is the lack of definitive seniority rights of various creditors, which can make renegotiation a prolonged and costly process that reduces welfare. Problems of coordination between different creditors and between creditors and the debtor that can arise because of uncertain or ill-defined creditor rights may explain the prolonged and costly process of restructuring emerging market debt. In a second-best world, the net effect of reducing these costs could be negative or positive, depending on the details of other multiple market failures.

The consumption-smoothing model without self-enforcement constraints helps illustrate this point. The standard noncontingent debt contract raises welfare, smoothing consumption forward, by implementing the standard Euler condition,

$$u'\left(c_t\right) = E_t u'\left(c_{t+1}\right), \tag{9}$$

for equal discount rates for both sides of the market (as assumed here). Total wealth and the marginal utility of consumption follow martingales. The first-best option is implemented by state-contingent, pure insurance contracts, so that

$$c_t = c_{t+1}, \tag{10}$$

in all events. The steady state is achieved immediately in the unconstrained first-best option. In the equilibrium of the permanent income model with noncontingent debt, the country's welfare will fall below its autarchy welfare (utility from consuming the stochastic endowment every period) with positive probability. Therefore, when self-enforcement constraints are imposed, the probability of defaults against the standard debt contract is positive. For state-contingent contracts, self-enforcement constraints owing to debtor sovereign immunity and limited lender liability impede full consumption smoothing, but the constrained efficient equilibrium reduces consumption volatility and reaches a stochastic steady state.

2. Implementing State-Contingent Repayments

The constrained efficient equilibrium for sovereign borrowing can be supported by a long-term state-contingent contract or by an implicit contract achieved through renegotiation of standard short-term debt contracts. Short-term contracts suffice because the self-enforcement constraints arise, since neither lenders nor borrowers can commit to making net foreign payments. New net loans or repayments are made because the lender or the borrower, respectively, gains by doing so, looking forward.

The constrained efficient equilibrium is characterized with proof in Kletzer and Wright (2000). I give a brief summary here, with some extension. The sovereign borrower's endowment has a finite support given by $0 < y^1 < y^2 < \ldots < y^N$. The endowment at time t, y_t, follows a stationary Markov chain over these N values that displays first-order stochastic dominance. For each y^j, the borrower's consumption in equilibrium lies in an interval, denoted

$$\left[\underline{c}^j, \overline{c}^j\right],$$

where $\underline{c}^j \leq y^j \leq \overline{c}^j$. The upper and lower bounds on these intervals satisfy

$$y^1 = \underline{c}^1 < \underline{c}^2 < \ldots < \underline{c}^N < y^N \quad \text{and}$$

$$y^1 < \overline{c}^1 < \overline{c}^2 < \ldots < \overline{c}^N = y^N$$

for a large range of discount rates. Consumption is smoothed as much as possible across states within the bounds of these intervals. That is, if y rises from y^1 to y^2 in period $t + 1$, then c_{t+1} will equal either c_t or $\underline{c}^2$, whichever is larger. Consumption ratchets upward or downward following the endowment. Since consumption is not fully smoothed in general, consumption in any state depends on lagged consumption as well as the current endowment. Therefore, consumption is smoothed against small income drops, and it falls with large ones. When income recovers, consumption is again smoothed for small increases and rises for large endowment increases. For a coefficient of variation in GDP growth equal to 3 to 4 percent (which are reasonable values for Latin America), partial smoothing in this model is possible for real discount rates on the order of 3 to 5 percent for intertemporal elasticities of substitution on the order of 0.3 to 0.5. These are reasonable ranges.

Consumption can be translated into net repayments, τ, which therefore also follow a Markov chain, $\tau_t = \tau(\tau_{t-1}, y_t)$, were τ_t is increasing in both arguments. This net transfer can be written as the difference between gross capital inflows, new loans, ℓ_t, and gross repayments, $R_t(\ell_{t-1}, y_t)$. Repayments are state-contingent, and loans are single-period contracts. Under free entry by lenders, expected profits for each loan satisfy

$$E_t\pi = -\ell_t + \beta E_t R_{t+1}(\ell_t, y_{t+1}) = 0. \tag{11}$$

The present value returns to creditors can thus be written as

$$U_t^c = \tau_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t}\tau_s = R_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t}\left[-\ell_{s-1} + \beta R_s(\ell_{s-1}, y_s)\right], \tag{12}$$

so that creditor surplus at date t is

$$U_t^c = R_t .$$

This is restricted to be greater than or equal to zero by the self-enforcement constraint.

The proper interpretation is that the constrained efficient equilibrium can be implemented by a sequence of single-period loan contracts with nonnegative contingent repayments. These can be implemented by implicit contracts using standard noncontingent debt contracts with renegotiated repayment. The contract made at time $t-1$ will be the pair,

$$\ell_{t-1} \text{ and , } \bar{R}_t = \max_{y_t} R_t(\ell_{t-1}, y_t),$$

as suggested by Grossman and Van Huyck (1988), which will be achieved for the highest state, y^N. Renegotiation results in repayments $0 \le R_t(\ell_{t-1}, y_t) \le \bar{R}_t$.

The self-enforcement constraint imposed on creditors is essential for interpreting state-contingent repayments as renegotiations. The constraint formalizes the assumption that lenders only make net resource transfers to sovereign debtors if they anticipate receiving future repayments in return that are at least as great in expected present value. That is, net real transfers from foreign lenders are loans. If the constraint, $U_t^c = R_t \ge 0$, is relaxed, then an implicit contract no longer works. Lenders must commit in period $t-1$ to make positive payments in some states in period t that leave them with lower utility than if they simply stop transacting with the debtor if R_t can be negative. Commitment requires exogenous enforcement and an explicit contract specifying performance.

Worrall (1990) analyzes consumption smoothing with one-sided commitment. Bulow and Rogoff (1989b) also assume creditor commitment and argue that international lending cannot be supported by reputational equilibria. Kletzer and Wright (2000) explain how the assumption of creditor commitment is essential to the argument and indicate that renegotiation-proof reputational equilibria only fail if the lenders provide pure insurance (that is, if lenders commit to making indemnity payments that they will prefer to renege on).[2] If international insurance is enforced by creditor country governments, however, international capital flows are supported and begin with the accumulation of foreign assets by the emerging market economy, as implied by the equilibrium in Worrall (1990). When only one side of an insurance or loan contract can commit, the first payment must be made by the party that cannot commit.

The equilibrium in the case of foreign creditors that can commit future payments to the sovereign borrower can be summarized using the same notation. The upper bounds, $\bar{c}^j$, are removed along with the constraint,

$$U_t^c = \tau_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} \tau_s \geq 0 \, .$$

Debtor consumption is smoothed against output decreases, and it rises with output. This means that consumption rises monotonically over time to a completely smoothed steady state. Net payments by the debtor decrease monotonically over time.

In practice, sovereign debt renegotiation is a tedious, prolonged, and costly process. External debt exposure also contributes to domestic public and private consumption volatility. This is just the opposite of what should happen in theory. Proposals for introducing GDP-indexed securities, or commodity bonds for primary-commodity-dependent exporters, have been revived recently. The theoretical model summarized above suggests that there should be gains from introducing bonds with

2. The argument that reputational equilibria are not credible is addressed by Kletzer and Wright (2000), who show that renegotiation-proof equilibria with free lender entry exists with self-enforcement constraints. Wright (2001) proves that this result survives creditor commitment if creditors are imperfectly competitive.

GDP-contingent repayments. Implementing the implicit repayments, $R_t(\ell_{t-1}, y_t)$, as GDP-indexed repayments is straightforward in theory. Such contracts should be feasible as long as GDP measurement is clearly defined and not subject to moral hazard. Borensztein and Mauro (2004) discuss the feasibility of GDP-indexed bonds and report preliminary estimates of their benefits.[3]

Caballero (2002) proposes commodity bonds, while Kletzer, Newbery, and Wright (1992) suggest that derivatives linked to commodity prices can be combined with international bonds to eliminate sovereign default risk. The latter paper uses the one-sided commitment model, so that foreign investors sell put options on export commodity prices to the debtor. The debtor exercises the put options when the commodity price falls below the strike price. This puts a floor on the value of the debtor's supply of primary exports, thereby eliminating default risk when commodity prices are low. Similar put options can be suggested for GDP.

Consider a two-state example, in which GDP equals y^1 with constant probability p and y^2 with probability $1 - p$. To make the example more general, let consumption be incompletely smoothed, so that consumption equals $\bar{c}^1$ in state 1 and $\underline{c}^2$ in state 2, where $\bar{c}^1 < \underline{c}^2$. The GDP-linked bond that implements the constrained efficient equilibrium with two-sided self-enforcement satisfies

$$\ell - R(y^1) = \bar{c}^1 - y^1, \quad R(y^2) - \ell = y^2 - \underline{c}^2, \text{ and} \tag{13}$$

$$\ell = \beta\left[pR(y^1) + (1-p)R(y^2)\right]. \tag{14}$$

The solution for the loan principal, ℓ, and the repayments, $R(y_t)$, also solves the constraint on creditor expected profits in state 1:

$$y^1 - \bar{c}^1 + \frac{\beta}{1-\beta}\left[p(y^1 - \bar{c}^1) + (1-p)(y^2 - \underline{c}^2)\right] = 0. \tag{15}$$

The solutions for repayments are

$$R(y^1) = 0 \text{ and } R(y^2) = y^2 - y^1 - (\underline{c}^2 - \bar{c}^1)\pi. \tag{16}$$

3. Cordella and Levy-Yeyati (2004) discuss the challenge of adverse policy incentives under moral hazard for country insurance.

That is, for the case of symmetric information, the full debt is forgiven for the lowest state.

These consumptions could also be implemented using a combination of a put and a call option that would pay off, on net, $\overline{c}^1$ when the put is exercised and $\underline{c}^2$ when the call is exercised. Another pair of contracts is to combine a GDP put option with a noncontingent foreign bond. The pair of contracts that implement the constrained efficient equilibrium in this case are a put option with a strike price of

$$y^{\text{STRIKE}} = y^2 - \left(\underline{c}^2 - \overline{c}^1\right) \leq y^2 , \tag{17}$$

with a premium equal to

$$p = p\left[y^2 - y^1 - \left(\underline{c}^2 - \overline{c}^1\right)\right] \tag{18}$$

and a loan in the amount of

$$\ell = \left(y^2 - \underline{c}^2\right)\frac{1-p}{\beta\left[1-\beta\left(1-p\right)\right]} , \tag{19}$$

with noncontingent repayments, R = ℓ/β. In the case of foreign creditor commitment, the steady state contracts are just these with $\underline{c}^2$ and $\overline{c}^1$ set equal because steady-state consumption is fully smoothed when foreign insurance is available.

These contracts clearly offer significant insurance for the sovereign debtor, but the gains from creating such markets are subject to the caveat that asymmetries of information and moral hazard are not yet introduced. Suppose that GDP put options were used to eliminate the idiosyncratic growth risk to ensure the capacity of public and private borrowers in an emerging market to repay bonds and loans as contracted with noncontingent interest. The put premium would equal the expectation of the potential drop in GDP over the term of the option, as shown by equation 18.

For a commodity-dependent exporting country, export revenue risk could be insured using put options. Since markets for important commodity derivatives exist and are liquid, the policy issue is whether the term of such options can match market cycles. Options with near-term expiration dates are not useful for insuring aggregate debt service requirements. Pricing sufficiently long options may not be a practical difficulty, but market liquidity could be.

3. Debt Contracts and Infrequent Renegotiation

The market equilibrium discussed thus far is implemented by implicit contracts in which state-contingent repayment is common. This implies that renegotiation of traditional debt contracts would be frequent. The model also assumes no asymmetries of information. Moral hazard in international debt restructuring is thought to be important and motivates an incomplete information extension of the model. Asymmetric information about debtor willingness to pay can also lead to standard debt contracts with noncontingent repayment and infrequent renegotiation. Again, I only outline the model here.

Sovereign immunity is still represented by self-enforcement constraints, but the debtor's endowment is private information. Cole and Kocherlakota (2001) study a model with hidden endowments and without commitment constraints. Thomas and Worrall (1990) make these assumptions with one-sided commitment and a finite support for the borrower's endowment. They prove that an equilibrium exists with two-sided self-enforcement constraints. Contracts are chosen so that the sovereign debtor reveals its hidden endowment in its choice of contract. Contracts are incentive compatible. They are also complicated. Using the hidden endowment model captures essentials of moral hazard in debt renegotiation. Atkeson (1991) model moral hazard in policy choices by sovereigns, while Eichengreen, Kletzer, and Mody (2004) provide a simple model of debt renegotiation.

The equilibrium is found by again maximizing debtor surplus over autarchy,

$$V_t = u(c_t) - u(y_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} \left[u(c_s) - u(y_s) \right],$$

with respect to c_t, reported y_t, θ_t, and promised surplus for creditors for period $t + 1$, $\{U^c_{t+1}\}$, subject to the self-enforcement constraints for the debtor and creditors,

$$V_{t+1} \geq 0 \text{ and } U^c_{t+1} \geq 0,$$

equation 7, and an additional set of incentive compatibility constraints. The incentive compatibility constraints are written as

$V_t(y_t, y_t) \geq V_t(\theta_t, y_t)$, for $q_t = y^1, \ldots y^N$, where the notation summarizes that consumption and promised creditor surplus vary depend on reported endowment, θ_t.

A surprising simplification arises if the support for the endowment is a continuous closed interval. Following Townsend (1979), the incentive-compatible contract will be a conventional short-term bond contract as long as the self-enforcement constraint does not bind with positive probability in the repayment period. The dynamics of the permanent income model are also informative. A low realization for output, when the sovereign immunity constraint does not bind, leads to repayment of interest and an increase in the outstanding debt. The expected marginal utility of consumption rises. A high realization leads to partial debt amortization, reducing outstanding debt, and the expected marginal utility of consumption falls.[4]

What happens when the constraint binds? The Euler condition is not satisfied since the country is at a corner, so that

$$u'(c_t) \geq E_t u'(c_{t+1}) \,. \tag{20}$$

Incentive compatibility allows characterization of the new implicit contract. For $u¢(c_t) > E_t u¢(c_{t+1})$, the debtor's utility must satisfy

$$u(c_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(c_s) = u(y_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(y_s)\,, \tag{21}$$

under the contract for period t, and the contract must repeat itself. That is, the debtor's utility will remain the same in period t + 1 if $u'(c_t) > E_t u'(c_{t+1})$ under the implicit contract. This contract is the lower bound for the debtor. Therefore, for any state such that $u'(c_t) > E_t u'(c_{t+1})$, the debtor receives the same contract for the next period, implying that the same net repayment must be made in all these states. If this were not true, the debtor would claim it was in the state with the lowest current net repayment required. Incentive compatibility rules this out. The next step is to observe that this can only be the lowest utility contract satisfying the self-enforcement constraint (equation 21) if $c_t = y_t$ when the self-enforcement constraint binds and $u'(c_t) > E_t u'(c_{t+1})$.

If, instead, $u'(c_t) < E_t u'(c_{t+1})$, and sovereign immunity binds, then the debtor makes a net repayment and is rewarded with higher utility under the contract taken in period $t + 1$. Under this incentive-compatible contract, the borrower's consumption is given by

4. The formalization of the equilibrium in this economy awaits a forthcoming paper.

$c_t = y_t$ for $y_t \leq \hat{y}$ and

$c_t < y_t$ for $y_t > \hat{y}$,

and c_t is increasing in y_t for all y. The critical value, $\hat{y}$, is in the interior of the support for debtor output. The debtor's surplus over autarchy in the next period contract will also be increasing in y. All this implies that creditor's claims remain constant in this contract for $y_t \leq \hat{y}$ and decrease between t and $t + 1$ if $y_t > \hat{y}$.

What happens in the subsequent period when $y_t > \hat{y}$ helps us to interpret the equilibrium contracts. The borrower receives a contract that gives it surplus over autarchy. This is the same a reduction in its debt. Since creditors do not ever observe y_t but do observe the payments made to or by the sovereign debtor, their surplus, U_t^c, in the market is not state contingent. Conventional debt satisfies these conditions. If the self-enforcement constraint will not bind with positive probability in period $t + 1$, the new implicit contract is a conventional short-term bond contract with certain repayment. On the other hand, if the sovereign immunity constraint can bind with positive probability, the bond contract will not be fulfilled with certainty. A risk premium will be added to the riskless interest rate $(1/\beta - 1)$.

When the sovereign immunity constraint binds and $y_t \leq \hat{y}$, the contract repeats, implying that creditor surplus is the same in period $t + 1$ as in period t, but no net payments are made in period t. The lowest creditor surplus satisfies

$$\bar{U}^c = \beta \bar{U}^c ,$$

which implies that only net interest is lost in renegotiation. This is the worst that happens to creditors in equilibrium, although interest is lost when the borrower's indebtedness is greatest. The equilibrium can be implemented by a conventional bond with renegotiation in low states when the debt level is sufficiently high. Renegotiation of repayments is necessary only when the debtor's utility and endowment are both sufficiently low. There is an upper bound on the true present value of the country's debt given by

$$\bar{D} = \bar{U}^c .$$

One more step is needed for understanding debt renegotiation. Continuity of the support for debtor output implies continuity in the implicit contract for any debt level. For the highest debt level, a rise in y leads to both net capital outflows from the debtor and a reduction in future debt. This means that any repayments, however small, include debt amortization. If this were not true, the debtor would not benefit from repaying anything, since the country's welfare would not be raised in the future by doing so. There must be a future benefit. That means that all the current interest is implicitly forgiven in debt renegotiation when $y_t \leq \check{y}$ and some interest is forgiven for higher y, until all the interest is paid plus additional debt amortization for the highest output level. This last part is necessary to make creditors as well off in the market as out. The net interest paid equals

$$r(y_t, \bar{D})\bar{D} = (y_t - c_t) - (D_{t+1} - \bar{D}),$$

where $r(y_t, \bar{D})$ indicates the dependence of the implicit contingent interest rate on the borrower's debt and current output.

4. Implementation with Bonds

Adding imperfect information implies that debt renegotiations do not occur continuously, but only occur in low output states for high outstanding debt. These stylize the facts of debt defaults and restructurings in emerging markets. Because contracts need to reveal private debtor information, it is natural to think of the state-contingent parts of the implicit contracts as the outcome of renegotiations between creditors and sovereigns who are better informed than their creditors about their willingness to pay.

The implications for country insurance are twofold. First, the required insurance must, at a maximum, cover the net interest on outstanding foreign debt. This is much smaller than the coverage needed under perfect information, because the welfare benefits of access to foreign credit are smaller as a consequence of asymmetric information. Second, any derivatives that are used to strip the renegotiation risk need to be incentive compatible for the debtor.

Consider a swap of the risky interest payments on the debt, $r(y_t, D_t)D_t$, for riskless interest payments made with certainty, $(1/\beta - 1)D_t$. Bondholders swap away the risky net interest payments to counterparties who hold risky default swaps. The contingency for the risky interest payments is the reported output for the debtor, not an independently observed signal. The renegotiable debt contracts are incentive compatible because the borrower's debt is reduced (partly amortized) at the same moment that it makes a contingent interest payment. If these are separated across foreign creditors, then the incentives for truthful reporting can fail. Debt amortization and risky interest payments need to be linked. This is a problem of market incompleteness as a result of moral hazard.

On the positive side, the information asymmetry might be viewed as a theoretical artifice to generate lending using conventional bond contracts with infrequent debt restructuring and ignored as a barrier to GDP- or otherwise-indexed derivatives. Perhaps this could be justified by assuming that the diversification needs of foreign investors and the costs of underwriting bonds and loans are such that bondholders delegate monitoring of sovereign debtors. If the monitoring costs are fixed, bond markets will be greatly disadvantaged relative to syndicated bank lending to emerging markets. Banks can internalize the costs once for all depositors as delegated monitors, while bondholders each need to be informed. Implementing the interest swap would support bond lending under these circumstances if the risky interest payments can be purchased by an informed investor, who would play the role of a delegated monitor.

Under these conditions, bonds would be issued with noncontingent interest that would be paid unless the debtor deviated from the implicit contract, effectively repudiating its obligations in part or whole. The holder of the interest swap would guarantee bondholder interest and monitor the debtor's circumstances. This could be separated further by considering a series of options based on debtor performance—say, GDP. For example, a GDP put option could pay interest. In the equilibrium for the model, risky interest payments rise with GDP for high debt levels. A series of puts with different strikes covering different shares of the interest payments on country debt could be used to fine tune the derivatives that underwrite bondholder interest. Bonds may need to include covenants requiring insurance against interest defaults of this nature. Such covenants may need to bind on a domestic agent rather than the foreign debtor, because bondholder monitoring of the debtor's derivative holdings could only be more costly than enforcing GDP-indexed interest payments. Structuring such interest swaps to facilitate bond borrowing without the risk of default could also be a way to support international borrowing by nonsovereigns within the emerging markets. An emerging market government itself could implement requirements that shift the interest risk away from bondholders to other willing investors.

5. Contractual Innovation to Reduce Renegotiation Costs

The recent debate over reforming the international financial architecture focuses on two alternatives: a statutory approach and a contractual approach. The statutory approach, which would introduce some form of international bankruptcy procedures for sovereigns, has currently been all but abandoned. The contractual approach is being pursued in the form of widespread adoption of collective action clauses in sovereign bond issues, notably those issued in the United States. The collective action clauses of concern allow a qualified majority of bondholders to be decisive with regard to restructurings of bond repayment terms.[5]

The debate over encouraging the adoption of collective action clauses has two aspects. Enabling renegotiation can raise welfare ex post, in the event of a bond default, but it can lower it ex ante if the net effect is to reduce capital inflows to emerging markets. The second effect can arise if reducing the costs of default raises the incidence of default. As argued in section 1, it is not easy to make renegotiation welfare reducing even under debtor moral hazard. Eichengreen, Kletzer, and Mody (2004) use a reduced model of willingness to pay to allow for asymmetric information and debtor moral hazard, following the renegotiation model in Kletzer (2003). They compare unanimous action clause bonds and collective action clause bonds in this simple model. Under unanimous action clauses, some creditors will hold out in renegotiation in equilibrium, leading to costly delays to agreement. Under collective action clauses, a sufficient minority of bondholders to hold up renegotiations will not do so. They are worse off if they delay agreement than if they join the majority in taking a negotiated settlement immediately. Eichengreen, Kletzer, and Mody (2004) show that the effects of collective action clauses on lending are ambiguous and depend on the degree of debtor moral hazard present. Lending can contract for high risk borrowers, but this should not be interpreted as welfare reducing. The borrower can receive more insurance with lower debt and avoid debt restructuring costs under unanimous action clauses.

Eichengreen, Kletzer, and Mody (2004) estimate the impact of collective action clauses on interest rate spreads and the probability of

5. A review of the policy issues is found in Dixon and Wall (2000).

issuance of both sovereign and nonsovereign emerging market bonds, and they proxy for moral hazard using country credit ratings. Low-rated issuers face higher spreads from collective actions clauses than do high-rated issuers. The second question in the debate concerns these results. The spread differences are small, which implies that collective action clauses do not matter much.

The main counterargument to contractual innovation is that foreign debt renegotiation may be made difficult as a market outcome enabling capital flows. The sovereign borrowing models summarized here point toward contractual innovations that may address this issue, in addition to introducing contingent contracts that reduce the need for costly debt renegotiations. Separating conventional bonds from risky GDP-indexed, commodity-price-indexed, or otherwise-indexed derivatives could support international markets in low-risk assets that simply are not renegotiated. This addresses the first issue. Reducing the incidence of costly renegotiations by formalizing contingencies in contracts that can be held by sophisticated investors can also raise welfare by increasing risk sharing for public and private borrowers in emerging markets.

6. Conclusion

External debt in emerging market economies is often a source of macroeconomic volatility, in that it requires increasing current account balances and fiscal contractions in the face of adverse productivity or international price shocks. Adverse macroeconomic shocks often lead to foreign debt repayment problems in heavily indebted countries, resulting in domestic financial distress. In many instances, sovereign debt restructuring has been a difficult, prolonged, and costly process. These events stand in stark contrast with the presumption that access to international capital markets should help countries to smooth domestic private and public consumption and investment over macroeconomic cycles.

The theoretical analysis of debt in the presence of international risk-sharing incentives suggests that debt renegotiation serves to implement an implicit contingent repayment schedule for international credit. The experience of debt crises and debt renegotiation can be interpreted as indicating a need for easing sovereign debt renegotiation. It might also be interpreted as creating a need for contractual innovation in international finance by more creative application of financial innovations in the most advanced financial markets to emerging market finance. The theoretical models described herein suggest that derivative contracts might be useful for sharing risk, thereby eliminating bond renegotiation as a way of implementing risk sharing. Such derivatives would allow debtors to insure themselves as parties to the contracts while reducing default and restructuring risk for bondholders. If markets in such securities are feasible, they could reduce macroeconomic volatility in indebted countries and increase capital flows to emerging market economies.

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Exchange Rate Interventions and Insurance: Is Fear of Floating a Cause for Concern?

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Fear of floating has recently come to be seen as one of the central de facto characteristics of exchange rate regimes in emerging markets, after first being identified by Calvo and Reinhart (2002). The interpretation of this phenomenon is still open to question. Does the optimal monetary regime for emerging markets with open capital markets entail limited exchange rate flexibility? Is the famous trilemma of open economies really a dilemma (as formulated by Shambaugh, 2004) for emerging markets—a choice between open capital markets or monetary freedom with no separate choice of exchange rate policy? Or is the trilemma alive and well? Does the pervasive fear of floating indicate instead that many emerging markets inadvisably choose to limit exchange rate flexibility when a genuine floating regime would be preferable?

Although the literature on this topic could be classified along many dimensions, this paper focuses on the extent to which fear of floating is the optimal policy for emerging markets. The literature can be divided into works that focus on deriving fear of floating as the optimal ex post monetary policy, taking into account the particular economic environment and shocks faced by emerging markets, and works that focus on the ex ante effects of monetary policy, where anticipation of exchange rate policy can drive inefficient private sector decisions. The main factors that are claimed to support fear of floating ex post are the

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pass-through of (excessive) exchange rate volatility into domestic inflation, the costs to inflation credibility this might entail, and the contractionary effects of a devaluation on an economy with a high level of dollarized liabilities. In contrast, Caballero and Krishnamurthy (2004) argue that although limited exchange rate flexibility is often the optimal discretionary policy ex post, it distorts the private sector's incentives to insure itself ex ante against sudden stops in capital inflows. If the private sector anticipates that the exchange rate will be defended during a crisis, its own incentives to hoard international liquidity are weakened. Such anticipation can be the ex ante cause of the excessive dollarization that supposedly validates fear of floating ex post. Fear of floating is not optimal, but it is the equilibrium policy in the absence of a commitment to float during crises. Countries can improve their insurance against sudden stops by giving the private sector the right incentives, either through a commitment to a floating exchange rate or through various substitute policies that we discuss later in the paper.

The purpose of this paper is to explore the tension between these approaches and its implications for exchange rate policy in emerging markets. We examine the question of whether fear of floating is simply the optimal policy choice in a difficult environment or a suboptimal equilibrium with too little exchange rate flexibility during external crises. We take the view that these explanations are not necessarily mutually exclusive, in that fear of floating may have different aspects under different circumstances. In the face of less severe external shocks, when the supply of international liquidity is not exhausted, countries will optimally stress the ex post considerations while preferring to avoid the inflationary effects of exchange rate instability. This does not preclude that the exchange rate be allowed to float during severe crises, when international liquidity shortages are binding; the commitment to this stance ex ante provides maximal insurance against such events. In this view, while floating exchange rates can have important incentive effects, the exchange rate does not need to float freely under all circumstances for these effects to obtain. This leads naturally to the concept of state contingency. It is impossible to evaluate the consequences of fear of floating without understanding the circumstances under which such exchange rate rigidity occurred. Perhaps the significant unconditional fear of floating that the literature identifies masks conditional flexibility during external crises.

We develop a simple model that captures a trade off between ex ante and ex post considerations. The are two states of nature, a "good" state, during which international liquidity is sufficient, and a "bad" state, or crisis, during which constraints on the supply of international liquidity are binding. The optimal policy with commitment is indeed state contingent along the lines described above, with policymakers intervening to stabilize the exchange rate and prevent inflation pass-through when there is no crisis, but allowing the exchange rate to float if a potential crisis occurs, for its effect on expectations.[1] We also consider two second-best policy regimes: the discretionary policy, which is determined ex post with no commitment, and the noncontingent policy with commitment. As in Caballero and Krishnamurthy (2004), the discretionary policy will exhibit inefficient fear of floating during crises and forego the insurance benefits of the floating exchange rate, but it does not compromise the benefits of exchange rate stability during normal times. The noncontingent policy with commitment is viewed as a proxy for the process of building commitment to floating, during which time it might be necessary to avoid intervention altogether. Although this brings the benefits of improved ex ante insurance against external shocks, it also carries short-term costs in the form of the greater inflation pass-through that floating entails.

To empirically identify state contingency, we develop an indicator of potential sudden stops as a proxy for the bad state of nature described above. The indicator is derived from the spread on a broad index of high-yield debt. A rise in high-yield spreads is treated as a (common) exogenous negative shock to external financing conditions for emerging markets and, as such, as a potential sudden stop. We compare the behavior of the exchange rate regime in periods with and without external pressure and then classify the state-contingent exchange rate regime. It is important to emphasize that we evaluate state contingency with respect to potential sudden stops. This allows us to address the question of whether the exchange rate regime has an effect on the likelihood of actual sudden stops, which are treated as endogenous, and hence to evaluate the insurance provided by floating exchange rates.

Classifying exchange rate regimes according to their behavior during potential sudden stops reveals that many countries display little difference in the degree of exchange rate flexibility during potential crises and other times, and their exchange rate flexibility is uniformly low. These emerging markets are viewed as operating under a discretionary exchange regime. Another group of emerging markets

1. Preventing inflation pass-through is not the only ex post channel through which fear of floating can be justified. We focus on one channel to keep the model streamlined.

does not exhibit state contingency because their exchange rate flexibility is uniformly high. These countries cannot be described as exhibiting fear of floating, and we interpret these countries as noncontingent regimes committed to floating. Finally, a few countries do exhibit fully state-contingent exchange rate flexibility.

After characterizing exchange rate behavior in the face of potential crises, we then proceed to investigate the extent to which the choice of regime can be given a normative interpretation. In particular, does widespread fear of floating during potential crises imply that a commitment to floating would be beneficial? To answer this question, we explore insurance substitutes. As discussed in Caballero and Krishnamurthy (2004), sterilization of capital inflows and direct financial regulation can substitute for the incentives provided by a commitment to floating. We examine the data, but find little evidence of such substitute policies. The model suggests that fear of floating should therefore be associated with underinsurance against liquidity crises. We test this hypothesis by examining two outcomes, the likelihood of suffering a sudden stop and the link between the exchange rate regime and the self-insurance of the private sector. In both cases, we find evidence that fear of floating matters. Less flexibility during potential crises is associated with a greater probability of an actual sudden stop.[2] More flexible regimes, in turn, lead to greater hoarding of foreign exchange reserves by the private sector. Finally, we investigate the determinants of exchange rate regime choices. A key ingredient in the analysis is the credibility of monetary policymaking. The model suggests that state-contingent regimes require the most credibility, noncontingent floating an intermediate level of credibility, and discretionary policy the lowest level of credibility. The data give some support to this hypothesis, showing an association between floating exchange rates and the overall credibility of the monetary policy framework, as measured by the commitment to inflation targeting.

The outline of the paper is as follows. Section 1 describes the theoretical framework we use to approach the data. Section 2 describes the data and methodology and provides an outline of the empirical facts. Section 3 provides a more formal analysis of the time series measures of exchange rate flexibility. Section 4 examines the consequences of the choice of exchange rate regime. Section 5 analyzes the determinants of exchange rate flexibility, and Section 6 concludes.

2. This result is not by construction. Exchange rate regimes are characterized in relation to potential crises, while the measure of sudden stops is an actual outcome.

1. Fear of Floating: Theoretical Discussion

As stated above, various models have been proposed in the literature to explain fear of floating. Calvo and Reinhart (2002) suggest that fear of floating can be explained by a monetary policy dilemma trading off the seigniorage benefits of inflation against the cost of deviating from an inflation target in an environment with risk premium shocks and a high pass-through of the exchange rate to the national price level. In their model, fear of floating is increasing in the size of the risk premium shocks and the extent to which inflation targeting is valued over seigniorage. Other authors, such as Aghion, Banerjee, and Bacchetta (2003), emphasize the balance sheet channel. Most studies in this group take as given the presence of substantial dollar liabilities that raise the risk of bankruptcies in the event of a devaluation. However, Céspedes, Chang, and Velasco (2004) present a model in which the balance sheet effects of dollarized liabilities do not necessarily overturn the standard Mundell-Fleming analysis that floating rates are better in the presence of external real shocks, since floating also has effects on the asset side. Lahiri and Végh (2001) rationalize fear of floating as the optimal policy in an environment characterized by an output cost of nominal exchange rate fluctuations, an output cost of raising interest rates to defend the currency, and a fixed cost of intervention. The fixed cost generates a nonlinearity in which fear of floating only arises for large shocks. Despite deriving fear of floating from different imperfections, for our purpose these models share the important feature that fear of floating is a characteristic of the optimal ex post monetary policy.

Caballero and Krishnamurthy (2004) offer a different view. Fear of floating arises in their model out of a time-consistency problem. Although it is optimal to tighten monetary policy ex post assuming the country is suffering an international liquidity crisis, such a policy increases the extent to which firms fail to conserve international liquidity ex ante. The central monetary policy issue for a country facing such sudden stops is to make certain that the private sector takes sufficient precautions to insure itself against such crises. A floating exchange rate is the optimal policy from an ex ante perspective as it raises the return to holding international liquidity, leads to increased hoarding of dollar liquidity, and helps to ameliorate the underinsurance of the private sector. The difficulty in implementing this policy is that the floating exchange rate is no longer optimal once a crisis occurs, since an exchange rate depreciation leads to inflation, and thus the time-consistent equilibrium entails fear of floating. In developing our theoretical model, the central insight we take from this analysis is the existence of a commitment problem with respect to floating.

The framework that we outline below combines elements from both approaches to exchange rate flexibility, and we assume that fear of floating can have a different aspect under different circumstances. In particular, we assume that there are two states of the world. In the "good" state, there is no shortage of international liquidity and, hence, the issue of insurance does not arise. In this case, the government optimally focuses on the ex post issues. In particular, the excess volatility of foreign exchange markets creates incentives to limit exchange rate volatility and prevent its pass-through into domestic inflation.[3] In the "bad" state, a shortage of international liquidity is binding. The policy should focus on the prevention of, or insurance against, such crises. In this case, fear of floating is not the optimal response, taking into account the ex ante effects on the incentives of the private sector to insure itself.

We examine the choice of exchange rate flexibility under three different assumptions about the government and its ability to commit. The discretionary regime is the optimal policy when the government cannot commit to floating during sudden stops, and so the policy is determined ex post. Such a policy will be optimal in the "good" state, but it will contribute to underinsurance during sudden stops in the "bad" state. The state-contingent regime assumes that the government can commit to floating during sudden stops but is also free to intervene in the good state without compromising that commitment. Finally, in the noncontingent regime, the government can commit to its exchange rate regime, but the private sector does not observe the state of the world. The government must therefore choose the same exchange rate flexibility at all times, since intervention during normal times can compromise the commitment to floating during crises.

The restriction on feasible policies in the noncontingent regime might appear ad hoc, as it is not derived endogenously within the model but simply imposed as an assumption. We consider this regime for several reasons. First, we think it is a useful approximation to the feasible floating policy for a country that needs to build credibility for its commitment to floating. Barro (1986) formally models a similar situation in the context of building a reputation for inflation credibility. In that model, the private sector is uncertain about the preferences of the

3. The forward discount bias is often attributed to noise traders. See Frankel and Froot (1989).

policymaker and the policymaker takes into account the fact that the private sector learns about these preferences through his actions. The equilibrium exhibits periods in which policymakers that are tough on inflation drive inflation to a very low level to demonstrate this fact until a reputation is established. We conjecture that a policy of noncontingent floating can operate in a similar manner when a reputation for floating during crises has not been established. Furthermore, this policy regime appears to describe the behavior of some countries in our empirical investigation, so we are compelled to consider it as a theoretical possibility.

1.1 A Model

The model draws heavily on the framework of Caballero and Krishnamurthy (2004), postulating an overinvestment problem in the "bad" state, which is the mirror image of the failure to optimally hoard sufficient international liquidity as insurance against sudden stops. Crucially, the extent of overinvestment depends on expectations of exchange rate policy. The framework is extended by postulating a desire to limit exchange rate flexibility in the "good" state, when there are no insurance issues, but the pass-through of exchange rate volatility into the price level is still a cause for concern. The optimal policy must resolve the tension between these goals, under different constraints on the policymaker's commitment. To simplify the exposition, we present the model in reduced form without explicitly considering the microeconomic foundations of the mechanisms through which exchange rate policy acts.

Consider a three-period economy. At time 0, firms make investment decisions. At time 1, a crisis may or may not occur that requires firms to make some reinvestment to maintain the productivity of their asset. At time 2, the economy consumes its output, which depends on both the investment at time 0 and the reinvestment at time 1. If a crisis occurs in period 1, the government faces ex post incentives to tighten monetary policy to protect itself against inflation, as in the literature in which fear of floating is optimal, since the insurance aspects of exchange rate policy are already sunk, but ex ante insurance concerns are foremost. If no crisis occurs, excess exchange rate volatility is still undesirable through its effect on prices, and fear of floating is optimal.

The insurance aspect of monetary policy is that firms' investment decisions at time 0 depend on expectations of the exchange rate during the crisis. The country is assumed to hold a fixed amount of international collateral that it can either use to finance investment at time 0 or hoard as insurance against a crisis at time 1. The exchange rate determines the price at which international collateral can be traded on the domestic market at time 1 and thus provides incentives for its accumulation or usage. A pecuniary externality leads to an undervaluing of international collateral (relative to the price that maximizes output at time 2), so firms overinvest at time 0 and conserve too little international collateral for the possible crisis at time 1. Monetary policy affects the exchange rate and thus has the power to correct this mispricing, but to achieve this the government has to commit to allowing the exchange rate to depreciate during the crisis. This raises the return to holding international liquidity, lowers the return to investing, and moves the investment decisions of firms closer to the output-maximizing level. The time-inconsistency problem arises since once the crisis occurs, the investment decision is predetermined and the exchange rate depreciation just raises inflation. This is costly to the government, so ex post the government prefers to limit exchange rate flexibility.

The objective function of the government is given by $W(Y, |\pi|)$, where $|\pi|$ is the expected absolute inflation rate that prevails in period 1, Y is the expected output of the economy in period 2, $W_y > 0$, and $W_{|\pi|} < 0$.[4] The output that is produced in period 2 depends on whether a crisis occurred. The states of the world in which no crisis occurs and a crisis occurs are denoted G and B, respectively, and the probabilities of these states of nature are p and $1 - p$, respectively. The economy produces $Y^G(K)$ if no crisis occurs and $Y^B(K)$ if a crisis occurs, where K is the investment level of the private sector in period 0. The crisis generates a production shock that requires further investment, and although the productivity of the capital stock is restored, the country ends up investing more to produce each unit of output. Thus $Y^G(K) > Y^B(K)$.

The inflation rate depends on the government's monetary policy via the exchange rate. We formalize monetary policy as a choice over the flexibility of the exchange rate, F, which in general can differ across the good and bad states, F^G and F^B. If the exchange rate is flexible during the potential crisis, the exchange rate depreciates and inflation increases. If the government chooses an

4. This objective implies that the government is equally averse to inflation and deflation. If we hold output (Y) constant, the optimal inflation rate is zero.

inflexible exchange rate, then depreciation and inflation are limited. Likewise, we assume that if no crisis occurs, excess exchange rate volatility would be passed into the price level under a flexible exchange rate.[5] We define the exchange rate, e, as the domestic price of one unit of international liquidity (dollars), so that larger values represent depreciations.

$$\pi = \pi(e) \text{ and } \pi_e > 0;$$

$$e = e(F), \quad \left|e^G\right|_F > 0, \text{ and } e_F^B > 0.$$

In reduced form, $\left|\pi\right|_F > 0$.

The investment decision, $K(e^B)$, depends on the (rationally expected) exchange rate that prevails in period 1, e^B, but only in the event that the crisis occurs. If the crisis does not occur, then firms do not require any further foreign capital, so the exchange rate in the good state does not affect the firms' objective function. Investment is not under the direct control of the government, although it determines welfare through output, Y. Consequently, the government must pursue its monetary policies taking into account the incentive effect that the exchange rate has on decentralized private sector investment decisions.

Monetary policy affects the investment decision of firms. Under the assumptions of Caballero and Krishnamurthy (2004), firms overinvest (relative to the output-maximizing level at time 2) unless the exchange rate is allowed to depreciate during crises. If the exchange rate is flexible in the crisis, investment decreases toward the output-maximizing level. Y^B increases, since more international capital is available during the crisis for reinvestment, and firms do not take decisions that maximize output owing to an externality (see Caballero and Krishnamurthy, 2004, for details). At the same time, Y^G declines, since in the absence of a crisis it is optimal to invest all available international capital in the domestic economy. Nevertheless, the assumption of an overinvestment problem implies by definition that the gain in a bad state outweighs the loss in a

5. There is an asymmetry in the shocks in the two states of nature. In the bad state, a shortage of international capital tends to depreciate the exchange rate if the government allows it to, so that π is positive and increasing in exchange rate flexibility F. In the good state, external shocks can lead to appreciation or depreciation. Although $|\pi|$ increases with F, the sign depends on the shock in the good state.

good state, so that expected output, Y, increases with exchange rate flexibility in the bad state, F^B.

$$K = K(e) \text{ and } K_e < 0\,;$$

$$Y_K^G(K) > 0\,,\; Y_K^B(K) < 0\,, \text{ but } Y_K(K) < 0\,.$$

In reduced form, we can write $Y^G(F^B)$ and $Y^B(F^B)$, where F^B is exchange rate flexibility in the bad state, with

$$Y_{F^B}^G < 0\,,\; Y_{F^B}^B > 0\,, \text{ and } Y_{F^B} > 0\,.$$

Finally we can write the government's problem as

$$\max_{F^G,\,F^B} W(Y, |\pi|) = W\left[(1-p)Y^G + pY^B, (1-p)\left|\pi^G\right| + p\left|\pi^B\right|\right].$$

The above analysis demonstrates that the government faces a tradeoff in choosing exchange rate flexibility, since

$$Y_{F^B} > 0\,,$$

which is beneficial, while

$$|\pi|_{F^B} > 0 \text{ and } |\pi|_{F^G} > 0\,,$$

which is undesirable. We will characterize the solution to this problem under the following three assumptions: the time-consistent discretionary policy, the optimal noncontingent policy with commitment, and the optimal state-contingent policy with commitment.

Case 1: The discretionary policy with no commitment

The time-consistent policy is chosen in period 1, taking investment decisions and the occurrence (or not) of the crisis as given. The fact that policy is chosen ex post implies that the government has the option of carrying out a state-contingent policy. We denote the exchange rate flexibility chosen in each state as F^B and F^G, where the index denotes the fact that the policy is chosen ex post in period 1.

If the crisis occurs, then the government solves

$$\max_{F} W(Y, |\pi|).$$

Once the crisis has occurred, monetary policy has no effect on aggregate output, which is predetermined by the aggregate capital stock and the remaining international liquidity. Therefore,

$$Y_F^B = 0\,,$$

and the first-order condition that determines the optimal F^B is given in terms of the marginal costs (MC_D^B) and benefits (MB_D^B) of exchange rate flexibility as

$$\mathrm{MC}_D^B = pW_\pi(Y,|\pi|)|\pi^B|_{F^B} \text{ and}$$

$$\mathrm{MB}_D^B = 0\,, \text{ so that}$$

$$0 = W_\pi(Y,|\pi|)|\pi^B|_{F^B}\,.$$

The government tightens monetary policy until either

$$W_\pi(Y,|\pi|) = 0\,,$$

in which case there are no further benefits to lowering inflation, or

$$|\pi^B|_{F^B} = 0\,,$$

in which case inflation cannot be lowered any further.

If the crisis does not occur then the government solves

$$\max_F W(Y,|\pi|).$$

The same reasoning implies that the optimal F^G satisfies

$$MC_D^G = pW_\pi(Y,|\pi|)|\pi^G|_{F^G} \text{ and}$$

$$MB_D^G = 0\,, \text{ so that}$$

$$0 = W_\pi(Y,|\pi|)|\pi^G|_{F^G}\,.$$

We obtain identical first-order conditions for the optimal flexibility, F, in both states. Under the simplifying assumption that the relation between absolute inflation, $|\pi|$, and flexibility is the same in both states, the discretionary policy exhibits no state contingency even though this is an a priori possibility.

Case 2: The noncontingent policy with commitment

Under this assumption, the government must commit to the same degree of exchange rate flexibility whether or not the crisis occurs. We denote the noncontingent optimal policy as F. The first-order conditions in terms of the marginal costs and benefits of flexibility are as follows:

$MC_{NC} = (1-p)W_\pi(Y,|\pi|)|\pi^G|_F + pW_\pi(Y,|\pi|)|\pi^B|_F = W_\pi(Y,|\pi|)|\pi|_F$ and

$MB_{NC} = (1-p)W_Y(Y,|\pi|)Y_F^G + pW_Y(Y,|\pi|)Y_F^B = W_Y(Y,|\pi|)Y_F$, so that

$W_Y(Y,|\pi|)Y_F = W_\pi(Y,|\pi|)|\pi|_F$.

In contrast to case 1, exchange rate flexibility carries both costs and benefits, since the decision is made ex ante when the incentive effects of exchange rate policy on expectations and output can be taken into account. At the margin, the optimal policy will trade off the insurance benefits of exchange rate flexibility ex ante (which operate through output) against the inflation costs ex post.

Case 3: The state-contingent policy with commitment

Under this assumption, the degree of flexibility is unconstrained across states of nature and the government can choose F^G and F^B separately. The first-order conditions for this problem differ according to the state.

In the bad state,

$MB_C^B = pW_Y(Y,|\pi|)Y_{F^B}^B$ and

$MC_C^B = pW_\pi(Y,|\pi|)|\pi^B|_{F^B}$, so that

$W_Y(Y,|\pi|)Y_{F^B} = W_\pi(Y,|\pi|)|\pi|_{F^B}$.

In the good state,

$MB_C^G = 0$ and

$MC_C^G = (1-p)W_\pi(Y,|\pi|)|\pi^G|_{F^G}$, so that

$0 = W_\pi(Y,|\pi|)|\pi|_{F^B}$.

During a potential crisis, it is optimal to trade off the insurance benefits of exchange rate flexibility against the cost of inflation. In other times, exchange rate flexibility offers no benefits (at the margin), so the optimal policy only takes into account the costs of inflation. This implies that the fully optimal policy is indeed state contingent, with more flexibility during potential crises.

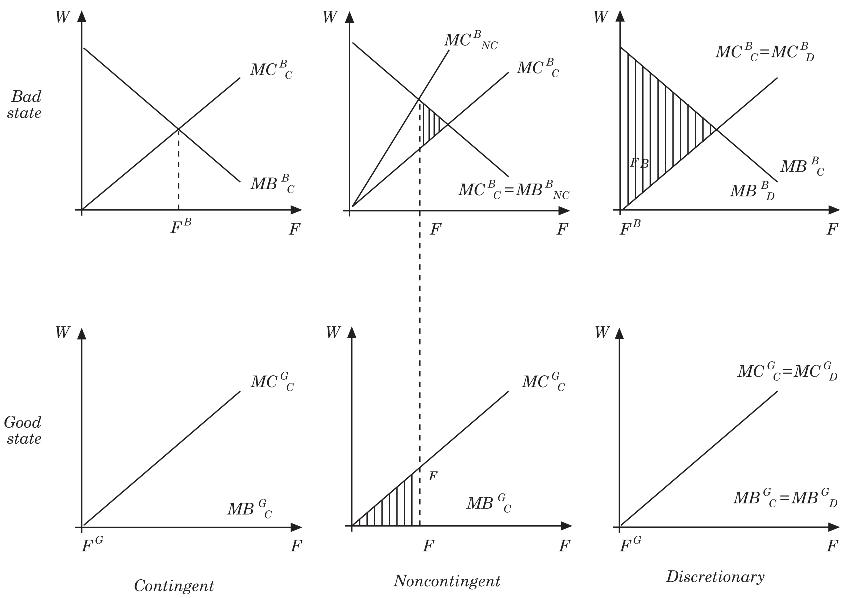
1.2 Comparing the Policy Regimes

The previous section solved the model under several different assumptions about the policy options of the government. We now need to rank these choices. The state-contingent policy dominates the noncontingent policy, which dominates the discretionary policy. The reason is simply that the set of feasible policies expands with credibility. The state-contingent policy sets a separate and fully optimal exchange rate policy for each state of nature, taking into account the ex ante insurance properties of exchange rate flexibility; as such, it must dominate any other policy option a fortiori, since every noncontingent policy is also a contingent policy and since it is always feasible, if superfluous, to commit to the discretionary policy. Likewise the discretionary policy implies the same exchange rate flexibility in both states of nature, so it is a feasible noncontingent policy, and the same argument applies.

Figure 1 illustrates the intuition. For each state of nature, the figure plots the marginal benefit and marginal cost of exchange rate flexibility as derived above, as well as the optimal degree of flexibility at the intersection of these schedules. For the noncontingent and discretionary regimes, losses in each state of nature relative to the fully optimal state-contingent policy with commitment are shaded. The noncontingent policy involves losses in both states of nature, as it entails too much flexibility in the good state and too little in the bad state. The discretionary policy is identical to the state-contingent policy in the good state, since it limits exchange rate flexibility, but it leads to suboptimal fear of floating in the bad state, since a flexible exchange rate would be preferable.

The next section examines the data on exchange rate flexibility through the model developed above and categorizes exchange rate regimes. We look for evidence of state-contingent flexibility that would mitigate the welfare implications of the fear of floating that the literature discusses. At the same time, we examine the outliers

Figure 1. Contingent, Noncontingent, and Discretionary Exchange Rate Flexibility[a]



a. For each state of nature, the figure plots the marginal benefit (MB) and marginal cost (MC) of exchange rate flexibility, as well as the optimal degree of flexibility at the intersection of these schedules. For the noncontingent and discretionary regimes, losses in each state of nature relative to the fully optimal state-contingent policy with commitment are shaded.

relative to the fear of floating category. These countries are not operating state-contingent regimes, but they are distinguished by their uniformly high level of flexibility.

2. Fear of Floating, Noncontingent Floating, and State-Contingent Flexibility

The methodological approach that we adopt to characterize exchange rate flexibility follows Calvo and Reinhart (2002). However, whereas Calvo and Reinhart characterize differences in unconditional exchange rate flexibility across countries relative to the benchmark floaters of Australia and the Group of Three (G3) countries, we extend this analysis to investigate whether exchange rate flexibility of emerging market floaters varies over states of nature.[6] We do not dispute that fear of floating characterizes the unconditional exchange rate regime across emerging markets, but we seek to determine whether this unconditional measure conceals flexibility with respect to shocks that are important from an insurance perspective.

The literature on the de facto classification of exchange rate regimes has burgeoned recently. Reinhart and Rogoff (2004) extend the analysis of Calvo and Reinhart (2002) by developing a de facto classification of exchange rate regimes, which shows a substantial number of deviations from the declared de jure regimes. The fear of floating manifests itself in the misclassification of regimes that de jure float, but de facto are less flexible. Levy-Yeyati and Sturzenegger (2003) develop a similar index, albeit based on a different classification methodology, and arrive at the same finding of extensive misclassification. Stambaugh (2004) constructs an alternative classification scheme. We follow the approach of Calvo and Reinhart (2002) for two reasons. First, the methodologies in the papers cited above are suited to the broad classification question of how to distinguish between fixed and flexible arrangements, whereas our investigation focuses on the differences within the group of de jure flexible regimes. Second, we want our results to be comparable with those reported in Calvo and Reinhart's paper, which started the fear-of-floating debate.[7]

To measure flexibility, we compare movements in exchange rates with movements in monetary policy instruments that affect the exchange rate. Examining the exchange rate in isolation is not informative about exchange rate policy, as it does not take into account the shocks that monetary policy faces. If the exchange rate is stable, we do not know whether it was due to policy choices despite shocks or to a lack of shocks. To deal with this problem, we define a flexible exchange rate as an exchange rate that is volatile relative to the

6. Germany has a fixed exchange rate as a member of the euro area, and it previously had limited flexibility under the exchange rate mechanism. Calvo and Reinhart's point, however, was that the currencies of the G-3 floated freely against each other.

7. Furthermore, the question of the correct classification methodology is far from settled. Different methodologies appear to be suitable for different purposes, and as Frankel (2003) notes, the correlation among different de facto measures is actually quite low. We therefore choose the measure that is most suitable for the questions we wish to address. For example, the correlation between the Reinhart-Rogoff (2004) and the Levy-Yeyati Sturzenegger (2003) classifications is 0.41, which is not much larger than the 0.33 correlation between the Reinhart-Rogoff (2004) and the much-maligned de jure classification.

instruments that could stabilize it. The implicit idea is that the policymaker faces a choice about how to accommodate a given external shock: it can be allowed to affect the exchange rate if policy is inactive, or the exchange rate can be insulated if policy is active. Exchange rate flexibility is about the relative volatilities of the exchange rate and instruments, not about the absolute volatility of either in isolation.

We follow Calvo and Reinhart (2002) in using changes in reserves and interest rates as measures of the monetary policy instruments available to the authorities and, hence, as measures of the degree of intervention. Using these variables is not without problems, however, and we review some of the issues here.[8] We risk errors of omission and commission in using changes in reserves or interest rates as measures of intervention, and these potential biases might be more or less relevant depending on whether the goal is to determine the within-country state contingency of exchange rate flexibility or to compare exchange rate regimes across countries. Nevertheless, we use these measures despite the many qualifications or issues of interpretation, because they are the best data that we have available and because they are used in previous studies with which we would like to compare our results.

Reserves can change for reasons unrelated to intervention, in particular the accrual of interest and the management of foreign currency debt. However, since we focus on large movements in reserves, we are not likely to misclassify an accounting change of reserves as an intervention because of the magnitude of the changes on which we focus. We are thus unlikely to be biased toward measuring too much intervention. On the other hand, reserve movements can be "hidden," for example when they involve credit lines or derivative transactions that are not reported on the balance sheet. We might miss some of these interventions and then misclassify regimes as not intervening when in fact they are. This would not be a problem if our intention was to establish fear of floating, as it would bias our results toward finding flexibility and thus make the hypothesis harder to establish. However, since one of our major goals is to investigate the circumstances in which the exchange rate regime becomes more flexible, it is possible that our findings could be explained by a change in the method of intervention toward "hidden" transactions. This could be a problem for establishing state contingency both within a country (if the change in the means

8. Calvo and Reinhart (2002) also discuss some of the same issues.

of intervention is correlated with the shocks we use to measure state contingency) and across countries (if countries with apparently flexible regimes are more likely to use "hidden" transactions).

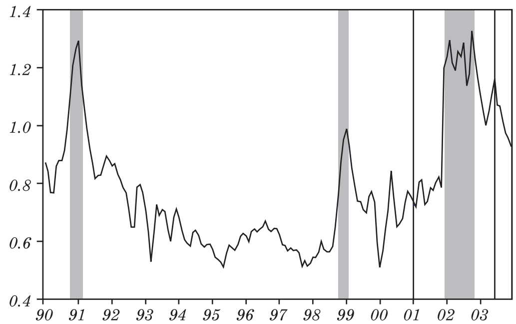
We also face several issues with regard to using interest rates as measures of foreign exchange intervention. The first is the extent to which the interest rate is genuinely an instrument of exchange rate management. Calvo and Reinhart (2002) present much anecdotal evidence that interest rates in emerging markets are active instruments of exchange rate management, but Shambaugh (2004) presents more systematic evidence that interest rate policy is not uniform across emerging markets, and countries with more flexible exchange rates have more autonomy in setting their interest rates. If interest rates are not just tools of exchange rate management, we risk misclassifying episodes as interventions when they are not. This would present a problem for the within-country results only to the extent that the shocks that we use to measure external crises had a direct effect on the domestic economy, separate from the exchange rate channel, and interest rate policy responded directly to these effects. This does not seem a very plausible assumption. The issues are more serious when we turn to cross-country comparisons, since the empirical measures of interest rates that are available across countries are far from uniform, and policy interest rates—which are the most natural counterpart to the theoretical analysis—are not always available. Thus the extent to which interest rate policy is directed toward exchange rate management may vary across countries, In addition, we may introduce biases related to systematic differences in the interest rate series we use across countries. If the extent of misclassification varies systematically with exchange rate flexibility (for example, if more flexible exchange rates increase the autonomy of monetary policy, so that the interest rate can be directed to domestic macroeconomic objectives), then there would be a bias toward finding fear of floating. This issue is relevant for the results in Calvo and Reinhart (2002), although they do not discuss it, and it makes it more difficult for us to establish circumstances in which exchange rates are flexible.

As in Calvo and Reinhart (2002) we first adopt a relatively atheoretical approach to exploring the data. To measure exchange rate volatility, we compute the probability that the monthly percentage change in the nominal exchange rate is within a given band. To measure instrument volatility, we examine the movement of foreign exchange reserves and interest rates. We denote the absolute value of the percent change and the absolute value of the change in variable x by $\hat{x}$ and $|x|$, respectively, and x^c represents a critical threshold. We are interested in the probability that the variables $\hat{x}$ or $|x|$ are less than x^c. We follow Calvo and Reinhart (2002) in considering percent changes for nominal exchange rates and international reserves (setting x^c equal to 2.5 percent), and absolute changes for nominal and real interest rates (setting x^c equal to 400 basis points). We use bands to measure volatility as they are less dependent on outliers than are variances, and they are also less likely to misidentify changes in instruments as interventions because they focus in big policy changes. We also carry out a more formal analysis using variances in the next section.

To examine whether flexibility varies when the country faces a potential sudden stop, we use a measure of high yield spreads (defined as the difference between Moody's seasoned Aaa and Baa corporate bond yields) to capture a source of exogenous financial pressure. Shocks are measured as the difference between the logarithm of the actual series and its trend as measured with the Hodrick-Prescott filter. In particular, we define a period of external pressure as an episode in which either the shock is one standard deviation above its average or the change in the actual series is one standard deviation above its average. These two dimensions imply that we are defining potential crises as periods when the level or the change in high yield spreads were particularly high. Consequently, the periods that qualify under this definition are October 1990 to April 1991; October 1998 to March 1999; January 2001; December 2001 to December 2002; and June 2003.

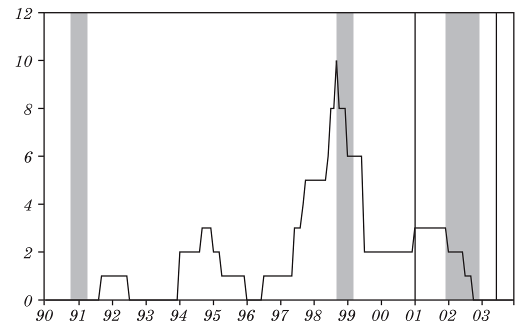
This variable is intended as an exogenous source of potential financial pressure. Since we are interested in the preventive properties of exchange rate regimes, it would not be correct to look at actual crises. Our goal is to examine exchange rate choices during episodes in which countries had a choice about whether to pursue a tight monetary policy or to let the exchange rate depreciate. We therefore pay careful attention, in our interpretation of the results, to whether we have excluded all false positives related to actual crises, when even fixed exchange rates can pass through periods of turbulence. At any rate, such "false positives" concerning exchange rate flexibility are more likely to occur in situations combining low levels of reserves and financial crises, which we already partially excluding with the sample selection (see below). The index of high yield spreads (HYS) and the periods identified as potential sudden stops are illustrated in figure 2.

Figure 2. The High-Yield-Spread Index and Potential Sudden Stops[a]



Source: Authors' calculations.
a. The line plots the high-yield-spread index; the shaded area represents potential sudden stops.

Figure 3. Actual and Potential Sudden Stops[a]



Source: Authors' calculations.
a. The line represents actual sudden stops; the shaded area represents potential sudden stops.

Figure 3 shows the relation between potential and actual sudden stops. The index of actual sudden stops in emerging markets is based on the definition of Calvo, Izquierdo, and Mejía (2004) and is discussed more fully in section 4. As the figure illustrates, while many actual sudden stops occurred during the period of turmoil in emerging markets in 1998–99, fewer occurred in 2001–2002, when the index of potential crises indicates a high level of external pressure. This less-than-perfect correlation between actual and potential sudden stops is not a problem for the analysis that follows. First, to classify exchange rate regimes, it is more important to identify a plausible exogenous shock than to explain all sudden stops. Second, we are interested in explaining when the common high-yield-spread shock becomes a country-specific sudden stop. The fact that the relation between high yield spreads and sudden stops exhibits some variation allows us to investigate which factors can account for this. In particular, the increased adoption of flexible exchange rates has been associated with increased insurance against potential external crises (see section 4).

2.1 Data

All our analyses use monthly data from the *International Financial Statistics* (IFS) published by the International Monetary Fund (IMF). The nominal exchange rate is the monthly end-of-period bilateral dollar exchange rate (source: IFS line ae). Reserves are measured using gross foreign exchange reserves minus gold (source: IFS line 1L.d). Regarding nominal interest rates, we follow Calvo and Reinhart (2002) in using policy interest rates whenever possible. As these vary by country, we use interbank rates for Argentina, Australia, Brazil, India, Indonesia, Malaysia, Mexico, Pakistan, Singapore, South Africa, and Thailand (source: IFS line 60B), deposit rates for Chile (source: IFS line 60L), discount rates for Colombia and Peru (source: IFS line 60). and Treasury bill rates for Israel and the Philippines (source: IFS line 60C).

The sample was chosen to include emerging economies that are sufficiently developed so as to have access to capital flows, so that they face the open economy policy dilemmas described above. In particular, we only incorporate countries that are included in the Morgan Stanley Capital International (MSCI) index.[9] In contrast to Calvo and Reinhart (2002), we consider only the period starting in 1990 because this is when voluntary capital flows to these economies become substantial. We exclude the transition economies because they experienced shocks and reforms of a very different nature in the 1990s. We further limit our analyses to exchange rate regimes with some de jure exchange rate flexibility, so that we include only regimes classified as managed floating or independent floating as reported to the IMF. Finally, we exclude regimes with severe macroeconomic instability since the macroeconomic issues are very different for economies with high inflation.[10] For each

9. J.P. Morgan's Emerging Markets Bond Index (EMBI) is probably a better-known index for emerging markets, but it has frequently changed the sample definitions. We therefore focused on the MSCI to define the sample used here.

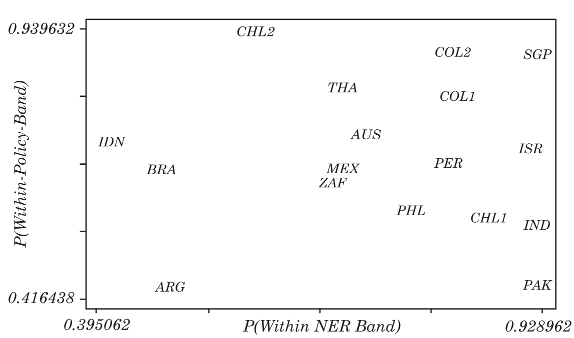
10. Reinhart and Rogoff (2004) assign these regimes to a separate category of "freely falling" in their de facto analysis, arguing that floating exchange rates are qualitatively different under very high inflation.

episode, we exclude the three months before and after any explicit change of exchange rate regime to avoid contaminating the results with transition effects.

2.2 Stylized Facts

We first use the measure of exchange rate flexibility described above to discuss the unconditional fear of floating described in the literature. We compute the relative frequencies of large exchange rate movements and large policy changes and plot them in figure 4. In particular we plot on the horizontal axis the sample probability that the nominal exchange rate remains within the band, which is a measure of exchange rate stability, and on the vertical axis the sample probability that the instruments remain within the band as a measure of instrument volatility. The volatility of policy instruments is a weighted average of the volatility of the nominal interest rate and the volatility of reserves, using the variance of each instrument's volatility as weights.

Figure 4. Fear of Floating: The Unconditional Evidence[a]



Source: Authors' calculations.
a. The horizontal axis plots the sample probability that the nominal exchange rate remains within the band, a measure of exchange rate stability; the vertical axis plots the sample probability that the instruments remain within the band as a measure of instrument stability.

To interpret the diagram, it is useful to consider the slope of the line connecting each point to the origin as a measure of exchange rate flexibility. The steeper the slope the more volatile the exchange rate relative to the policy instruments. Movements along a ray toward the origin represent more volatility in both the exchange rate and policy instruments, without changing the relative volatility of either;

these movements can thus be interpreted as a measure of the shocks with which exchange policy had to contend during the sample period. The diagram includes Australia, which Calvo and Reinhart (2002) use as a benchmark floating economy.[11]

Fear of floating can clearly be observed in this figure, although it is far from uniform as a de facto characterization of emerging market floating exchange rates. According to this crude measure of exchange rate flexibility, few emerging markets have exchange rate regimes that are more flexible than Australia. Only Brazil and the newly independent floating regimes of Chile, Indonesia, and Thailand appear to have more flexibility. Mexico and South Africa, which have a similar policy stance to Australia, appear to face more volatile external conditions. At the other extreme, Pakistan and India behave very similarly to pegs.

Drawing policy implications from this diagram is difficult, however, as it is not possible to determine the circumstances that led to these policy choices. To address this question, we need to compare exchange rate flexibility across periods with and without external pressure. Table 1 presents the evidence on the flexibility of the exchange rate and instruments, controlling for whether the country is faced by external pressure. We estimated the effects by running a regression of a binary variable (which takes a value of one if the variable is within the band and zero otherwise) and our indicator of periods of external pressure. This procedure is equivalent to comparing the probability that each variable is within the relevant band in periods with and without external pressure. We use this evidence to explore the extent to which there are emerging markets that are not characterized by fear of floating and, among those that are, to look for signs of state-contingent flexibility in the face of external pressure.

Figure 5 presents this data in a diagram, with a combined measure of instrument volatility as used in figure 1. Again the slope of the line connecting each point to the origin can be interpreted as exchange rate flexibility. The two panels compare exchange rate flexibility under the base case with that when the country faces external pressure. Two findings stand out from this diagram. First, this analysis appears to confirm that Brazil, Chile, Indonesia, and Thailand are characterized by more exchange rate flexibility under the normal circumstances of the base case. These countries are not accurately characterized by fear of floating. Second, the figure provides evidence of state-contingent

11. They argue that unlike the G-3, which are not useful comparators for emerging markets because their currencies are held as international reserves, Australia has a freely floating policy and is subject to similar external shocks to many emerging markets.

Table 1. Volatility of Exchange Rates, Reserves, and Interest Rates[a]

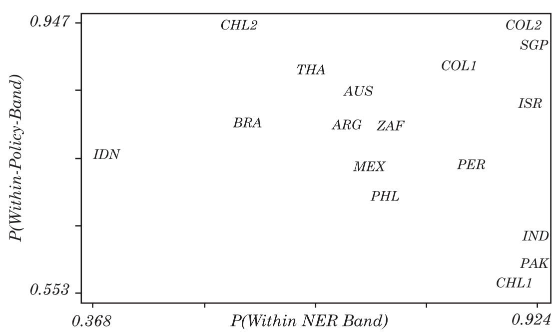
				Nominal exchange rate		Reserves		Interest rates	
Country	*IMF classification*	*Start*	*End*	*Base case*	*HYS shock*	*Base case*	*HYS shock*	*Base case*	*HYS shock*
Argentina	Managed float	Jan 2002	Dec 2004	0.667	0.300*	0.333	0.200*	1.000	0.200*
Australia	Independent float	Jan 1989	Dec 2004	0.681	0.786	0.500	0.536	1.000	1.000
Brazil	Independent float	Jan 1999	Dec 2004	0.543	0.267*	0.478	0.400	0.935	1.000*
Chile	Managed float	Jan 1989	Aug 1999	0.870	0.692	0.620	0.539	0.520	0.385
Chile	Independent float	Sep 1999	Dec 2004	0.526	0.667	0.895	0.933	0.973	1.000
Colombia	Managed float	Jan 1989	Sep 1999	0.802	0.846	0.663	0.846*	0.970	0.846
Colombia	Independent float	Oct 1999	Dec 2004	0.892	0.667*	0.838	0.733	1.000	1.000
India	Managed float	Jan 1989	Dec 2004	0.916	0.769	0.430	0.385	0.713	0.42
Indonesia	Independent float	Aug 1997	Dec 2004	0.368	0.524	0.719	0.667	0.750	0.762
Israel	Managed float	Dec 1991	Dec 1999	0.909	0.833	0.432	0.833*	1.000	1.000
Mexico	Independent float	Jan 1995	Dec 2004	0.693	0.667	0.480	0.706*	0.841	0.905
Pakistan	Managed float	Jan 1989	Dec 2004	0.924	0.964	0.160	0.179	0.785	0.857
Peru	Independent float	Aug 1990	Dec 2004	0.822	0.741	0.619	0.407	0.778	0.778
Philippines	Independent float	Jan 1989	Dec 2004	0.715	0.857*	0.420	0.464	0.806	0.857
Singapore	Managed float	Jan 1989	Dec 2004	0.917	0.893	0.762	0.786	1.000	1.000
South Africa	Independent float	Jan 1989	Dec 2004	0.722	0.464*	0.347	0.714*	0.993	1.000*
Thailand	Independent float	Jul 1997	Dec 2004	0.621	0.905*	0.724	0.762	0.931	1.000*

Source: Authors' calculations, based on International Monetary Fund, *International Financial Statistics*.
* The values in the base case and the HYS shock are significantly different at the 5 percent level.
a. Nominal exchange rate volatility is the probability that the monthly change is within a +/–2.5 percent band. Reserve volatility is the probability that the monthly change is within a +/–2.5 percent band. Interest Rate volatility is the probability that the monthly change is within a +/–400 basis point band.

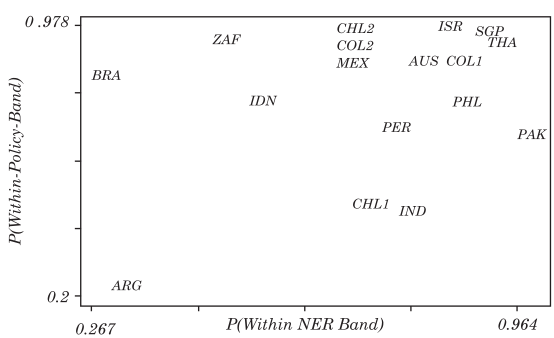
flexibility for some countries. In particular, both South Africa and Mexico exhibit similar flexibility to Australia during normal times but have a higher degree of flexibility during periods of external pressure.

Figure 5. Contingent Flexibility

A. Base case



B. High-yield-spread shocks



Source: Authors' calculations.

Under the interpretation of figures 4 and 5, the flexibility of the exchange rate changes in periods of external pressure if and only if the slope of the line connecting each point to the origin changes. Figure 6 develops a simple way of testing this hypothesis. We define exchange rate flexibility in normal times and under external pressure as F^G and F^B:

$$F^G = \frac{P(\text{Policy\_in\_band}/\text{No\_shock})}{P(\text{NER\_in\_band}/\text{No\_shock})};$$

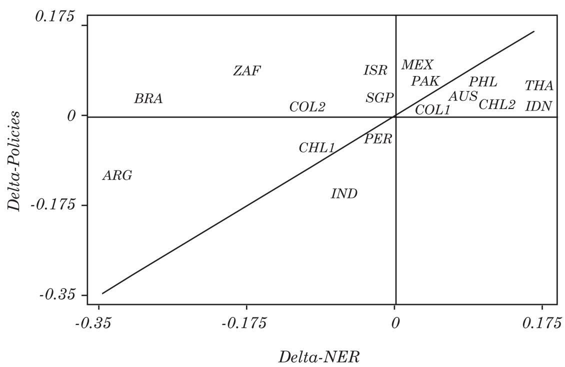
$$F^B = \frac{P(\text{Policy\_in\_band/Shock})}{P(\text{NER\_in\_band/Shock})}.$$

The exchange rate regime is more flexible under external pressure if and only if $F^B > F^G$, which can be written, after taking logarithms and rearranging, as follows:

$$\Leftrightarrow \quad \ln P(\text{Policy\_in\_band/Shock}) - \ln P(\text{Policy\_in\_band/No\_shock}) > \ln P(\text{NER\_in\_band/Shock}) - \ln P(\text{NER\_in\_band/No\_shock})$$

$$\Leftrightarrow \quad \Delta(\text{Policies}) > \Delta(\text{NER}).$$

Figure 6. Contingent Flexibility: High-Yield-Spread Shocks[a]



Source: Authors' calculations.
a. The figure plots (in logs) the change of the policy response against the change in the nominal exchange rate response. Points above the diagonal represent countries that are more flexible during periods of external pressure; points below the diagonal exhibit the opposite behavior.

Figure 6 thus plots the change (in logs) of the policy response against the change in the nominal exchange rate response. Points above the diagonal represent countries that are more flexible during periods of external pressure, while points below the diagonal exhibit the opposite behavior. Many countries are located on or around the diagonal, suggesting that these countries do not exhibit much state contingency. Some of these countries, such as Chile, present high levels of flexibility in both normal and shock periods, while others, as Pakistan, present low levels of flexibility in both situations. Argentina, Brazil, the more recent Colombian regime, South Africa, Israel, and Mexico exhibit some state-contingency. A few countries, such as India, Indonesia, and Thailand, lie below the diagonal, suggesting that these countries pursue more flexible policies in normal times than in periods of external pressure. However, while this is potentially another form of fear of floating, Thailand and Indonesia are being compared to a relatively high base level of flexibility, so this interpretation is not necessarily appropriate. Finally, Australia is also included in this figure as a falsification exercise. HYS shocks should not have a significant effect on Australia, so we would not expect to observe any difference in flexibility during periods of external pressure. This is exactly what we observe.

In summary, the figures suggest two basic findings. First, the unconditional data include several countries that exhibit less fear of floating than the Australia benchmark. Second, a few countries exhibit fear of floating, but on average allow more exchange rate flexibility during periods of external pressure. South Africa, in particular, stands out in this regard. Contingent flexibility also seems to be an aspect of exchange rate behavior in Brazil, Colombia, and Mexico. Argentina similarly appears to fall in this category, but it is not clear whether the increased flexibility is a result of choice or necessity.[12]

3. Exchange Rate Flexibility Index: Time-Series Analysis

To further support the claims developed above, we undertook a more formal analysis of exchange rate flexibility. We constructed a time-series index of flexibility analogous to that presented in Calvo and Reinhart (2002). The exchange rate flexibility index is defined as:

$$F = \frac{\sigma^2_{\check{E}}}{\sigma^2_{\check{R}} + \sigma^2_{|i|}},$$

where $\sigma^2_{\check{E}}$ denotes the variance of the nominal exchange rate, $\sigma^2_{\check{R}}$ the variance of reserves, and $\sigma^2_{|i|}$ the variance of the interest rate. To implement the measure, we construct at each point in time t a thirteen-month rolling window centered on t and compute the sample variance of each component variable. We thus derive a time series measure of exchange rate flexibility. The interpretation of this indicator is similar to the analysis above. To evaluate the degree of flexibility of an exchange rate regime, we

12. The analysis in section 3 finds that the apparent state contingency is not statistically significant.

incorporate information about the flexibility of both the exchange rate and policy instruments. More flexible regimes should display a high degree of exchange rate volatility vis-à-vis instrument volatility and, hence, a high value of F, while less flexible regimes should register a flexibility index of close to 0. We use a symmetric window incorporating both leads and lags of each variable, since we want to evaluate the effect of a shock by comparing the exchange rate and policies before and after the event.

Before we implemented the analysis, we corrected the index for two sources of bias in cross-country comparisons. The unconditional average of the index for each country was regressed against dummy variables for the index rate series used to control for the fact that some countries use more volatile market interest rates, while other countries employ a more stable policy interest rate series. A further potential source of bias arises from the fact that the floating exchange rate might be more volatile for some countries than others owing to different terms-of-trade shocks. We therefore added a variable measuring the volatility of terms-of-trade shocks to the regression. The index of exchange rate flexibility was then corrected with the coefficients from this cross-country regression.

For each episode (that is, for each regime included in the analysis), we run the following regression on the corrected flexibility index:

$$F_t = \alpha + \sum_{m=0}^{M} \beta_m \mathrm{HYS}_{t-m} + \sum_{n=1}^{N} \gamma_n F_{t-n} + \varepsilon_t \,.$$

We thus identify

$$\frac{\alpha}{1 - \sum_{n=1}^{N} \gamma_n}$$

as the long-run basis regime effect (that is, when there is no external pressure from the high yield spread and after incorporating the dynamics of F) and

$$\frac{\sum_{m=0}^{M} \beta_m}{1 - \sum_{n=1}^{N} \gamma_n}$$

as the long-run difference in the flexibility index between normal and (potential) crises times. We use the Schwarz information criterion to choose the optimal lag structure of the model. Table 2 presents a summary of the results of these regressions.

The results of this analysis mostly confirm the less formal stylized facts presented in section 2, although we discuss some important differences below. Regimes are classified as contingent (C), noncontingent (NC) and discretionary (D) according to the following algorithm. The coefficients for the long-run base effect and contingent flexibility are calculated from the time-series analysis. The contingent regimes are identified as those for which the coefficient

$$\frac{\sum_{m=0}^{M} \beta_m}{1 - \sum_{n=1}^{N} \gamma_n}$$

is significantly different from zero at 5 percent significance according to a Wald test. The other two regimes are distinguished based on a comparison of the base level of flexibility with two benchmark floating regimes, Singapore and Australia. If the coefficient

$$\frac{\alpha}{1 - \sum_{n=1}^{N} \gamma_n}$$

for a regime is significantly less than that of Australia or Singapore for the same time period (on the basis of a one-tailed Wald test), then the regime is classified as discretionary (fear of floating).[13] Otherwise, it is classified as noncontingent floating.

This algorithm produces a classification similar to the picture obtained in figure 4. Table 2 suggests that only four countries, Brazil, Colombia (after 1999), South Africa, and Mexico exhibit contingent flexibility.[14] South Africa apparently exhibits a high degree of base-line flexibility that is not statistically different from either Australia or Singapore, suggesting its contingent flexible is in addition to a flexible exchange rate. The other three contingent regimes exhibit significantly less flexibility than the benchmarks in the base case, suggesting that there

13. Although the base-level coefficient for Australia is less than that for Singapore, the sample for each significance test differences according to the dates of each regime. It is thus necessary to carry out both tests in each case.

14. The statistical analysis does not identify Argentina as a member of this group, despite appearances to the contrary in figure 5.

Table 2. Exchange rate flexibility index

Country	*IMF Classification*	*Start*	*End*	$\frac{\alpha}{1-\sum_{n=1}^{N}\gamma_n}$	$\frac{\sum_{m=0}^{M}\beta_m}{1-\sum_{n=1}^{N}\gamma_n}$	*Dynamic structure (M,N)*	*Category*[e]
Argentina	Managed float	Jan 2002	Dec 2004	0.2486[c]	0.2186	(0,1)	D
Australia	Independent float	Jan 1990	Dec 1999	0.4204	0.1733	(1,1)	Benchmark
Brazil	Independent float	Jan 1999	Dec 2004	0.2559[c]	0.4711[b]	(1,1)	C
Chile	Managed float	Jan 1989	Aug 1999	0.0720[c]	–0.0195	(0,1)	D
Chile	Independent float	Sep 1999	Dec 2004	0.6504	0.2778	(1,2)	NC
Colombia	Managed float	Jan 1989	Sep 1999	0.1512	0.3797	(0,1)	D
Colombia	Independent float	Oct 1999	Dec 2004	0.2882[c]	1.2369[b]	(0,1)	C
India	Managed float	Jan 1989	Dec 2004	–0.0078[cd]	0.0516	(0,1)	D
Indonesia	Independent float	Aug 1997	Dec 2004	1.2486	–1.1495	(0,1)	NC
Israel	Managed float	Dec 1991	Dec 1999	0.6078	4.7612	(2,5)	NC
Mexico	Independent float	Jan 1995	Dec 2004	0.3028[c]	0.4450[b]	(0,1)	C
Pakistan	Managed float	Jan 1989	Dec 2004	–0.0713[cd]	–0.0271	(1,4)	D
Peru	Independent float	Aug 1990	Dec 2004	0.1034[cd]	–0.1455	(1,1)	D
Philippines	Independent float	Jan 1989	Dec 2004	0.2826[c]	0.2299	(0,1)	D
Singapore	Managed float	Jan 1989	Dec 2004	0.6044	0.1291	(0,1)	Benchmark
South Africa	Independent float	Jan 1989	Dec 2004	0.2820	0.2079[b]	(0,3)	C
Thailand	Independent float	Jul 1997	Dec 2004	0.7609	–0.2832	(0,1)	NC

Source: Authors' calculations, based on International Monetary Fund, *International Financial Statistics*.

a. Covariance matrix computed with Newey-West standard errors. Lag structure determined by Schwarz information criterion. Flexibility index is corrected by differences in the variance of terms of trade and differences in the variance of the interest rate used to compute the index.

b. Indicates a regime with significant contingency at the 5 percent level using a Wald test.

c. The base case is significantly lower than Singapore at the 5 percent level using a Wald test for the same period of time.

d. The base case is significantly lower than Australia at the 5 percent level using a Wald test for the same period of time.

e. The categories are contingent (C), noncontingent (NC), and discretionary (D).

are indeed circumstances in which exchange rate rigidity is desirable provided that it does not undermine insurance. The other regimes do not exhibit contingency, but they do exhibit significant differences in flexibility. The regimes classified as discretionary exhibit fear of floating in all states of nature. These countries show an apparent inability to commit to floating exchange rates. The countries in the sample classified as discretionary are Argentina, Chile (before 1999), Colombia (before 1999)[15], India, Pakistan, Peru, and the Philippines. Finally the noncontingent, flexible regimes are Chile (after 1999), Indonesia, Israel, and Thailand. Australia and Singapore would also be considered members of this category, but they were defined as such for the purposes of categorizing the other regimes.

4. The Benefits of a Commitment to a Float

The above discussion classified regimes with state-contingent policies. Interpreting the classification, however, requires an understanding of the extent to which the choice of exchange rate regime is associated with insurance against external shocks This question can be addressed on two separate levels. The interpretation of exchange rate behavior is complicated by the fact that, as discussed in Caballero and Krishnamurthy (2004), alternative insurance mechanisms are available that can substitute for exchange rate flexibility, such as capital controls, reserve requirements, and sterilization of capital inflows. We first examine the extent to which our classification of discretionary regimes can actually be characterized more generally as uninsured regimes by investigating these substitutes. Nevertheless, examining policies alone is not sufficient to determine that the choice of exchange rate regime is important. Thus, we proceed to examine the extent to which floating exchange rates are associated with improved insurance against external shocks in terms of outcomes. We examine two pieces of evidence: the relation between sudden stops and the exchange rate regime, and the dynamics of private holdings of foreign exchange reserves.

Table 3 accounts for other substitute insurance policies. Controlling capital inflows directly can prevent the underinsurance from arising, but at the cost of limiting integration with international capital markets.

15. Although the statistical analysis did not select Colombia (before 1999) as significantly less flexible than either Australia or Singapore, the regime was qualitatively very similar to Chile (before 1999) and was classified accordingly as discretionary.

Capital controls are measured according to the index in Kaminsky and Schmukler (2003). Capital controls are clearly more prevalent in countries with discretionary regimes, suggesting that this policy substitutes for exchange rate flexibility. Nevertheless, capital controls are an extremely suboptimal response to the underinsurance problem in that they provide insurance only at the expense of isolation from international capital markets.

Table 3. Substitute Insurance Mechanisms

Country	*Capital controls*[a]	*Sterilization*[b]	*Quality of bank supervision*[c]	*Reserve requirements*[d]
Contingent regimes				
Brazil	1.8	0.11	3.0	16.4
Colombia (after 1999)	1.0	–1.15	2.0	12.7
Mexico	1.0	–0.67	2.0	15.7
South Africa	2.1	0.18	3.0	11.4
Average	1.5	–0.38	2.5	14.1
Median	1.4	–0.28	2.5	14.2
Noncontingent (floating)				
Chile (1999-)	1.0	–0.53	3.0	12.7
Indonesia	3.0	–0.91	n.a.	n.a
Israel	1.5	–1.14	2.5	9.5
Singapore	1.5	–0.83	3.5	18.4
Thailand	1.1	–0.84	3.0	11.4
Average	1.6	–0.85	3.0	13.1
Median	1.5	–0.84	3.0	12.1
Discretionary (fear of floating)				
Argentina	3.0	–0.60	2.0	8.8
Colombia (before 1999)	2.2	–0.78	2.0	12.7
Chile (before 1999)	2.0	–0.23	3.0	12.7
India	3.0	–0.26	2.0	11.9
Pakistan	3.0	–1.14	1.0	8.8
Peru	1.1	–0.57	3.0	12.8
Philippines	2.5	0.21	2.5	14.5
Average	2.4	–0.48	2.2	11.7
Median	2.5	–0.57	2.0	12.7

Source: Author's compilation; see notes.
n.a. Not available.
a. Capital controls index is from Kaminsky and Schmukler (2003). A value of 3 equals high controls; 1 equals low or no controls;
b. Update of the results from Bofinger and Wollmershaeuser (2001). The estimate corresponds to the coefficient of the change in net foreign assets in a regression of the change in net domestic assets on net foreign assets and lagged net domestic assets. Monthly data from IFS, lines 11 to 17.
c. Computed using the definition in Abiad and Mody (2003), with data from Barth, Caprio, and Levine (2003). A value of 4 equals best quality; 0 equals worst quality. The index incorporates information on banks' adoption of a capital adequacy regulation in line with standards developed by the Bank for International Settlements; whether the supervisory agency is independent from executive influence and whether it has sufficient legal power and (material) supervisory power; the absence of exemptions to mandatory actions if an infraction is observed; and the extent to which supervision covers all financial institutions.
d. From Barth, Caprio, and Levine (2003). The actual risk-adjusted capital ratio in banks is as of year-end 2001, using the 1988 Basle Accord definitions.

The second policy option suggested by Caballero and Krishnamurthy (2004) is sterilization of capital inflows. Although the efficacy of such a policy has been questioned, our goal here is simply to examine the facts. We use the methodology of Bofinger and Wollmershaeuser (2001) to evaluate the importance of sterilized interventions, We run the following regression for each country using monthly data for the relevant period for each regime:

$$\Delta\left(\mathrm{NDA}\right)_t = \alpha + \beta\Delta\left(\mathrm{NFA}\right)_t + \gamma\Delta\left(\mathrm{NDA}\right)_{t-1} + \varepsilon_t ,$$

where NDA represents the net domestic assets of the monetary authority and NFA is net foreign assets. With full sterilization, we expect β to be equal to -1, and with partial sterilization β should be less than 0 but greater than -1. This regression is a very crude measure of sterilization that may suffer from biases related to omitted variables and potential endogeneity, so we focus on comparing the estimates across groups, rather than on the estimated levels. The second column of table 3 presents estimates of β for each regime. This evidence is less clear. The results suggest that while discretionary regimes use sterilization, suggesting a further substitute insurance mechanism, noncontingent floating regimes do so even more. It appears that as the floating exchange rate gains credibility, sterilization becomes a complementary rather than a substitute policy. State-contingent regimes, which can be associated with higher levels of credibility, sterilize least of all, suggesting that once credibility has been gained, it is no longer necessary to complement floating with additional policies.

Finally, we present measures of financial regulation from Abiad and Mody (2003) and Barth, Caprio, and Levine (2003). Better supervision and prudential regulation can monitor balance sheet mismatches and help prevent the build up of excessive dollar liabilities. At the same time, better-functioning and well-developed financial markets increase the stock of assets that can be presented as collateral. Table 3 shows that financial development does not substitute for flexible exchange rates—in fact, it is the opposite. The least liberalized financial markets are found in countries with discretionary regimes. Although the differences are small, the most liberalized financial markets are found among the state-contingent regimes. In sum, we find some weak evidence that discretionary regimes undertake alternative policies to insure themselves against external shocks. Policies such as capital controls can be very costly, however, and they are unlikely to be superior to a well-managed open economy with flexible exchange rates.

The next results examine the extent to which the choice of exchange rate regime, in particular flexibility during potential crises, is associated with better insurance outcomes. Caballero and Krishnamurthy (2004) argue that better insurance occurs through the mechanism of altering private sector incentives to conserve international liquidity. Although such a proposition is difficult to test directly, some evidence in this direction is provided in table 4, which presents regression results that link the exchange rate regime to the international liquidity held by domestic residents in banks. Two specifications are estimated, with and without lags of the dependent variable for absolute and relative measures of private reserves:

Table 4. Private Reserve Accumulation and the Exchange Rate Regime[a]

Dependent and explanatory variables	*(1)*	*(2)*	*(3)*	*(4)*
Dependent variable: private reserves				
Log(GDP)	1.426**	1.398***	0.050***	0.051***
	(0.016)	(0.704)	(0.294)	(0.016)
F	0.375***	0.449***	0.013***	0.010
	(0.044)	(0.075)	(0.005)	(0.008)
HYS		0.182*		–0.002
		(0.114)		(0.007)
F*HYS		–0.097		0.006
		(0.079)		(0.009)
Log(PR)_{t-1}			0.967***	0.967***
			(0.010)	(0.011)
Dependent variable: share of private reserves in total reserves				
Log(GDP)	0.046	0.049	–0.040***	–0.042***
	(0.123)	(0.121)	(0.014)	(0.013)
F	0.022**	0.020	0.011***	0.009***
	(0.010)	(0.018)	(0.002)	(0.003)
HYS		0.019		0.009
		(0.030)		(0.007)
F*HYS		–0.001		0.002
		(0.020)		(0.004)
$[\text{PR} / (\text{PR} + \text{PuR})]_{t-1}$			0.413***	0.411***
			(0.057)	(0.057)
No. countries	14	14	14	14
No. observations	1,280	1,280	1,274	1,274

Source: Authors' calculations, based on International Monetary Fund, *International Financial Statistics*.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. Fixed-effect estimates. Standard errors (robust to clusters at the country level) are in parentheses.

$$\log(\text{PR})_{it} = \alpha + \beta \log(\text{GDP})_{it} + \chi F_{it} + \delta \text{HYS}_t + \phi \text{HYS}_t * F_{it} + \eta \log(\text{PR})_{it-1} + \mu_i + \varepsilon_{it} \quad \text{and}$$

$$\frac{\text{PR}}{\text{PR+PuR}}_{it} = \alpha + \beta \log(\text{GDP})_{it} + \chi F_{it} + \delta \text{HYS}_t + \phi \text{HYS}_t * F_{it} + \eta \left(\frac{\text{PR}}{\text{PR+PuR}} \right)_{it-1} + \mu_i + \varepsilon_{it}.$$

In these equations, *i* represents the country, *t* represents the month, PR represents private reserves as measured by international liquid assets in banks (source: IFS), PuR represents the international reserves held by the Central Bank as used in previous sections (source: IFS), GDP represents GDP in dollars (source: IFS), *F* is the (corrected) flexibility index used above, and HYS is the index of (potential) crises developed above. Country dummies are also included. As can be observed in table 4, there is a robust relation between private reserves and exchange rate flexibility, both in absolute terms and as a share of the total reserves of the country. As flexibility increases, the private sector hoards more dollar reserves. The interaction term is not significant, so it is exchange rate flexibility per se that is important and not just flexibility during crises.

The second set of regressions investigates the link between exchange rate flexibility and sudden stops. The hypothesis underlying these regressions is that the high-yield-spread series that we have used for classifying exchange rate regimes is a common external shock. Whether such a shock develops into a sudden stop depends on how insured the country is and, in particular, the dollar reserves on which it can draw during such an episode. To investigate this hypothesis, it is necessary to define sudden stops. The series constructed is based on Calvo, Izquierdo, and Mejía (2004), with the series updated to 2003. Calvo, Izquierdo, and Mejía (2004) define a sudden stop as a phase that meets the following two conditions: it contains at least one observation where the year-on-year fall in capital flows lies at least two standard deviations below its sample mean; and the phase ends once the annual change in capital flows exceeds one standard deviation below its sample mean. The beginning of a sudden stop is determined by the first time the annual change in capital flows falls one standard deviation below the mean. The appendix presents a complete list of the sudden stops identified by this methodology. We estimate the following equation:

$$\text{SUDDEN}_{it} = \alpha + \beta\text{HYS}_t + \chi F_{it} + \delta\text{HYS}_t * F_{it} + \mu_i + \varepsilon_{it} \,,$$

where SUDDEN is a dummy taking the value of one if there is an (actual) sudden stop and zero otherwise. F is the (corrected) flexibility index described above, and the HYS is the a dummy taking the value of one if there is a (potential) external crisis, as defined above. Random or fixed country-specific effects are included in some specifications.

Table 5 shows the results of estimating the equation described above with a probit model, a linear probability model, and a logit model (without country effects, with country fixed effects, and with country random effects).[16] In all cases, the coefficient of the interaction term is negative and significant. Exchange rate flexibility during a potential crisis significantly reduces the probability that the shock will develop into a sudden stop. In the three models, the marginal effect of increasing flexibility from 0 to 1 during a crisis is to reduce the probability of a sudden stop by between 7.9 percent and 12.2 percent, which is quantitatively large in comparison with the average sample probability of a sudden stop during a potential (12.4 percent).[17] It is the interaction, not the main effect, which is significantly negative. Thus, from the point of view of insurance against sudden stops, it is only the commitment to floating during periods of external financial pressure that leads to better protection.

We now link this analysis with the earlier discrete classifications of exchange rate regimes. The crisis dummy is intended to pick up only one plausible source of exogenous external pressure, to enable the classification of exchange rate regimes. Likewise, the results in table 5 measure the extent to which that same source of external pressure (which is a common shock) converts into a sudden stop (which is a country-specific outcome). If the classification is valid, there should be a significant relation between the regime classification and the likelihood of being subject to a sudden stop, even if that sudden stop were not associated with a high-yield-spread

16. Fixed-effect estimates using the probit model with panel data are severely biased owing to the incidental parameters problem (Wooldrige, 2002), so we do not present them.

17. In the case of the logit model with fixed effects, five countries (710 observations) were dropped because all outcomes were negative (that is, these countries did not have sudden stops during the period). In this case, the marginal effect of moving the flexibility index from 0 to 1 is –27.9 percent, which is a large magnitude considering that the probability that these countries will have a sudden stop during a crisis is 16.8 percent.

Table 5. Exchange Rate Regimes and Sudden Stops

	Panel-probit model		*Panel–linear probability model*			*Panel-logit model*		
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
F	0.327***	0.656***	0.069***	0.145***	0.140***	0.609***	1.223***	1.181***
	(0.094)	(0.104)	(0.022)	(0.026)	(0.021)	(0.170)	(0.202)	(0.177)
	[0.061]	[0.114]				[0.059]	[0.304]	[0.099]
HYS	0.172	0.113	0.033	0.020	0.021	0.327	0.231	0.230
	(0.116)	(0.138)	(0.023)	(0.021)	(0.022)	(0.222)	(0.250)	(0.245)
	[0.034]	[0.021]				[0.032]	[0.056]	[0.016]
F * HYS	–0.442**	–0.627***	–0.091**	0.122***	–0.120***	–0.822**	–1.127**	1.078**
	(0.199)	(0.240)	(0.040)	–(0.037)	(0.037)	(0.391)	(0.441)	(0.430)
	[–0.082]	[–0.109]				[–0.079]	[–0.279]	[–0.090]
Country effects	No	Random effects	No	Fixed effects	Random effects	No	Fixed effects	Random effects
No. countries	14	14	14	14	14	14	9	14
No. observations	2,279	2,279	2,279	2,279	2,279	2,279	1,569	2,279

Source: Authors' calculations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. Standard errors are in parentheses; marginal effects are in brackets.

shock on which we have focused. Table 6 addresses this question. It illustrates the sudden stops that occurred during the sample period and the exchange rate regime according to the classification in table 2. The link between exchange rate regimes and sudden stops appears to hold generally. In particular, sudden stops only occurred in countries with discretionary regimes.

Table 6. Country Episodes and Sudden Stops

Sudden stop		*No sudden stop*	
Country	*Regime*	*Country*	*Regime*
Colombia (before 1999)	Discretionary	Argentina	Discretionary
Chile (before 1999)	Discretionary	Brazil	Contingent
Peru	Discretionary	Chile (after 1999)	Noncontingent
Philippines	Discretionary	Colombia (after 1999)	Contingent
		India	Discretionary
		Indonesia	Noncontingent
		Israel	Noncontingent
		Mexico	Contingent
		Pakistan	Discretionary
		Singapore	Noncontingent
		South Africa	Contingent
		Thailand	Noncontingent

Source: Authors' calculations.

5. Determinants of State-Contingent Regimes

Emerging market exchange rate regimes vary considerably, and this variation is associated with important differences in the extent to which countries are insured against external shocks. What determines the choice of exchange rate regime? If the benefits of floating and, in particular, state-contingent regimes are so clear, why is fear of floating so pervasive? Our analysis suggests that an important obstacle to floating is the need to develop credibility for the exchange rate regime. This section examines two hypotheses—that the exchange rate regime is related systematically to the overall credibility of the monetary policy framework, and that credibility takes time to acquire, so that contingent floating is more likely to be found among countries that have a longer experience with a floating exchange rate regime than among countries that have recently implemented a float.

Table 7 tests these hypotheses. Monetary policy credibility is measured by the commitment to inflation targeting. We measure inflation targeting using the classification developed by Carare and

Stone (2003), which identifies countries that have implemented full-fledged inflation targeting regimes. They characterize such countries as those having a medium to high level of credibility, a clear commitment to their inflation target, and an institutionalization of this commitment in the form of a transparent monetary framework that fosters the accountability of the central bank. This measure fits particularly well our notion of inflation credibility. The table shows that this measure of credibility lines up with the theoretical analysis in section 1. State-contingent regimes are more likely to have high levels of monetary policy credibility, noncontingent floating regimes are intermediate, and the regimes with the lowest degree of credibility exhibit, in general, discretionary fear of floating.

With regard to the time to acquire credibility for floating, the table does not exhibit very clear results. Among the floating regimes, the unconditional average age of noncontingent regimes is only slightly less than that of contingent regimes. However, regime misclassifications might be weakening these results. In particular, Brazil and Colombia (after 1999) switched to more flexible regimes following a sudden stop, and they are classified as involuntary transitions according to the index developed by the IMF (2004). Both countries have avoided suffering additional external crises, but it is perhaps too early to tell whether they are floating out of choice or necessity. Israel was a borderline case in the classification, as it exhibited a quantitatively large coefficient in the measure of state contingency that was nevertheless statistically insignificant. In line with the hypothesis, Chile and Indonesia are more recent entrants to the group of floating exchange rates. On the other hand, the state-contingent regimes contain some of the most experienced emerging market floaters, including Mexico and South Africa. This analysis must be considered an ex post rationalization, however, so the hypothesis remains only weakly proven.

The table also includes a measure of derivatives market development, based on data from the Bank for International Settlements. Some researchers argue that the development of derivatives markets fosters the development of exchange rate flexibility, by enabling the allocation of exchange rate risk to those most able to bear it and by fostering a more sophisticated approach to financial risk management. Such instruments might also substitute for contingency in policies and hence aid the transition to floating exchange rates. The data loosely support this hypothesis. Derivatives market development is most stunted in countries with discretionary exchange

Table 7. Determinants of Exchange Rate Regimes

Regime and country	*Inflation targeting*[a]	*Voluntary regime change*[b]	*Age*[c]	*Derivatives market development*[d]
Contingent regimes				
Brazil	0.9	0.0	62	0.9
Colombia (after 1999)	1.0	0.0	61	0.3
Mexico	0.6	0.0	103	1.5
South Africa	0.3	1.0	180	13.5
Average	0.7	0.3	101.5	4.1
Median	0.8	0.0	82.5	1.2
Noncontingent (floating)				
Chile (after 1999)	1.0	1.0	62	2.2
Indonesia	0.0	0.0	67	n.a.
Israel	0.6	1.0	96	0.9
Singapore	0.0	1.0	180	258.6
Thailand	0.5	0.0	83	3.9
Average	0.4	0.6	97.6	66.4
Median	0.5	1.0	83.0	3.1
Discretionary (“fear of floating”)				
Argentina	0.0	0.0	29	0.1
Chile (before 1999)	0.1	1.0	110	1.7
Colombia (before 1999)	0.0	1.0	111	0.0
India	0.0	1.0	180	n.a.
Pakistan	0.0	1.0	180	n.a.
Peru	0.0	0.0	132	n.a.
Philippines	0.0	0.0	112	n.a.
Average	0.0	0.6	122.0	0.6
Median	0.0	1.0	112.0	0.1

Source: Authors’ compilation; see notes.

a. The percentage of time in each regime that a full-fledged inflation-targeting regime has been in operation. Source: Carare and Stone (2003).

b. A voluntary transition is a transition that is not driven by a crisis. Crisis-driven transitions are defined as those that are associated with a depreciation of more than 20 percent vis-à-vis the U.S. dollar, a doubling (or more) in the depreciation rate of the previous year, and depreciation in the previous year of less than 40 percent. Source: IMF (2004).

c. Age is defined as the number of months that the country was under the regime until the end of the regime (defined in table 2) and that the regime was not classified as a de facto free-falling regime by Reinhart and Rogoff (2004).

d. Foreign exchange derivatives transactions to GDP. Source: BIS (1999, 2002).

rate regimes. Comparisons between the contingent and noncontingent floating regimes are harder to make, as there are few data points and several significant outliers. Furthermore, it is impossible to ascertain whether derivatives markets foster flexible exchange rates, flexible exchange rates foster derivatives markets, or both developments are jointly determined by some underlying fundamental cause. As such this remains a correlation.

6. Conclusions

We have reexamined fear of floating from the perspective that when policymakers in emerging markets determine exchange rate policy, they face a tradeoff between limiting exchange rate volatility and allowing the exchange rate to float. Fear of floating might indeed be the optimal policy for these economies in normal times, because excess exchange rate volatility is legitimately feared for its effects on inflation or firm balance sheets. Fear of floating is not always the optimal policy, however, since a commitment to floating would improve insurance against potential sudden stops. We have categorized exchange rate regimes in the light of this framework. Policymakers with little commitment will only be able to implement discretionary policies with little exchange rate flexibility, and fear of floating will be the result. With intermediate levels of commitment, floating during crises will be feasible, but noncontingent policies must be used to demonstrate the commitment to floating. Finally with full commitment, the optimal regime is state contingent—floating during (potential) crises, but retaining the option to intervene, if necessary, on other occasions.

With this framework in mind, we explored the empirical evidence on exchange rate flexibility in emerging markets. We covered some of the same ground as Calvo and Reinhart (2002) in their original paper on fear of floating, although we found much evidence that the picture is significantly more complicated than this one-dimensional characterization. There is indeed a lot of fear of floating in emerging markets, as Calvo and Reinhart found, but our analysis of state-contingent flexibility allows us to be more certain both in attributing this to an inefficient discretionary equilibrium and in arguing that more commitment to exchange rate flexibility would be beneficial for insuring these economies against sudden stops. These economies seem to choose to control capital flows rather than undertake any substitute insurance policies in the context of open capital markets, and the overall credibility of their monetary policy frameworks tends to be low.

At the same time, we found several emerging markets that are not characterized by fear of floating at all. Chile and Indonesia—two recent converts to floating—appear to be serious about developing a reputation for floating, and they are forgoing exchange rate intervention to demonstrate this. In accordance with the theoretical analysis, these economies can be characterized as having intermediate levels of credibility. Other analyses have also highlighted the exchange rate flexibility of these economies. Hernández and Montiel (2001) identify Indonesia as the only Asian country to move to free-floating following the crisis, and Frankel (2003) presents Indonesia as a successful floating exchange rate, given its subsequent recovery despite being hit with the worst of the Asian crisis.

Finally we found that several of the more mature floating exchange rates exhibit precisely the state-contingent flexibility that our theoretical analysis suggests would be optimal in this environment. They appear to be able to intervene under certain circumstances without compromising their commitment to floating during potential sudden stops, when floating is really important. Such economies exhibit high levels of monetary policy credibility. The clearest examples of such countries that emerge from our analysis are South Africa and Mexico.[18] These two countries were more or less able to isolate their economies from the periods of extreme external turbulence in the late 1990s. For instance, both countries allowed big movements in the nominal exchange rate in the late 1990s, and neither had sudden stops in that period (Calvo, Izquierdo, and Mejía, 2004). Moreover, their decline in growth rates were quite mild in comparison with other countries.

The South African case presents a particularly interesting study for emerging market floating regimes. It is an open middle-income country that experienced seven currency crises between the end of the Bretton Woods system and 1985 (Bordo and Eichengreen, 2002), which is high even by current standards of emerging market volatility. Since 1985, however, South Africa has applied a floating regime, and its commitment to this regime does not appear to be in doubt.[19] The South African Reserve Bank has explicitly stated that it does not target the level of the exchange rate, although it has a policy of intervening to "smooth out large short-term fluctuations in the exchange rate" (Mboweni, 2004). The commitment to floating has clearly been tested on several recent occasions, yet South Africa did not experience a sudden stop despite the turmoil in emerging markets (Calvo, Izquierdo,

18. South Africa is perhaps a more appropriate benchmark than Australia, which is the usual comparator for emerging market exchange rate regimes. The particular financial market shocks on which we have focused clearly have an impact on South Africa, while they have no impact on the Australian exchange rate regime, indicating that they probably do not represent external shocks at all.

19. It is one of the few emerging markets that the Reinhart and Rogoff (2004) classification reports as a freely floating exchange rate. It is classified as such starting in 1995, prior to which it is classified as a managed float.

and Mejía, 2004). It appears that a floating exchange rate is not only a feasible policy for emerging markets, but one that can be successfully used to insure the economy against external volatility without forgoing the option of occasionally intervene in turbulent markets. For more recent floaters such as Chile, this experience should prove an invaluable guide.

Appendix
Sudden Stops by Country and Period

This appendix presents our sample of sudden stops, which we calculated using the updated Calvo, Izquierdo, and Mejía (2004) methodology. This sample is used in figure 3 and section 4.

— Argentina: September 1994 to December 1995; February 1999 to December 1999; January 2001 to September 2002.
— Brazil: October 1997 to June 1999.
— Chile: June 1998 to June 1999.
— Colombia: July 1998 to June 2000.
— India: none.
— Indonesia: June 1997 to September 1998.
— Israel: none.
— Mexico: January 1994 to March 1995.
— Pakistan: none.
— Peru: September 1997 to December 1998.
— Philippines: September 1991 to June 1992; June 1997 to June 1999.
— Singapore: none.
— South Africa: none.
— Thailand: July 1996 to September 1998.

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Contingent Reserves Management: An Applied Framework

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One of the most serious problems that a central bank in an emerging market economy can face is the sudden reversal of capital inflows (or sudden stops). Hoarding international reserves can be used to smooth the impact of such reversals (see, for example, Lee, 2004), but these reserves are seldom sufficient and always expensive to hold.

In Caballero and Panageas (2005), we derive and estimate a quantitative model to assess the (noncontingent) reserve management strategy typically followed by central banks. We conclude that this strategy is clearly inferior to one in which portfolios include assets that are correlated with sudden stops. As an illustration, we show that holding contracts on the Standard and Poor's (S&P) 100 implied volatility index (VIX) can yield a significant reduction in the average cost of sudden stops.

This result should not be surprising to anyone who follows the practices of hedge funds and other leading investors. Institutional investors seldom immobilize large amounts of cash to insure against jumps in volatility and risk-aversion—except in the case of extremely frequent events, which sudden stops are not. The use of derivatives and the creation of the VIX are designed precisely to satisfy hedging needs. Why should central banks, which are the quintessential public risk management institutions, not adopt best practices for risk management?

In this paper we present a simple model designed to isolate the portfolio dimension of the reserves management problem. We estimate the key parameters of the model from the joint behavior of sudden stops

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and the VIX, which we then use to generate optimal portfolios. We show that in an ideal setting, in which countries and investors can identify the jumps in the VIX and in which there exist call options on the VIX, an average emerging market economy may expect to face a sudden stop with up to 40 percent more reserves than when these options are not included in the central bank's portfolio.

The main reason behind this important gain is the close relation we identify between jumps in the VIX and sudden stops. We estimate that the probability of a sudden stop conditional on a jump in the VIX is about four times the probability of a sudden stop in the absence of a jump. Another dimension of the same finding, which speaks directly of the hedging virtues of the VIX, is that the probability of a jump in the VIX is slightly above 30 percent when there is no sudden stop in emerging markets and over 70 percent when a sudden stop takes place in that year.

The paper is organized as follows. Section 1 presents a simple static portfolio model for a central bank concerned with sudden stops. Section 2 then solves the model under various assumptions on hedging opportunities. Section 3 discusses implementation issues. Section 4 quantifies the model, first illustrating the behavior of the VIX and its coincidence with sudden stops in emerging markets (represented by nine economies: Argentina, Brazil, Chile, Indonesia, Korea, Malaysia, Mexico, Thailand, and Turkey). It then estimates the different parameters of the model and reports the optimal portfolios for a range of relevant parameters. Section 5 documents the impact of the different hedging strategies on the availability of reserves during sudden stops, and section 6 concludes.

1. Basic Framework

We analyze the investment decisions of a central bank that seeks to minimize the real costs of a sudden stop of capital inflows. Our goal is to provide a simple model to isolate the portfolio problem associated with such an objective. We refer the reader to Caballero and Panageas (2005) for a dynamic framework that discusses the optimal path of reserves and the microeconomic frictions behind sudden stops. Here we simply take from that paper that when a sudden stop occurs, the country's ability to use its wealth for current consumption is significantly curtailed. The immediate implication of such a constraint is a sharp rise in the marginal value of an extra unit of reserves.

There are two dates in the model: date 0, when portfolio decisions are made, and date 1, when asset returns realize and a sudden stop may take place. We assume that a central bank's objective has the following form:

$$\max_{R_0,\pi} -\frac{\alpha}{2} E\left\{\left[R_1 - K - 1(\mathrm{SS})Z\right]^2\right\}, \tag{1}$$

where R_1 denotes total reserves at date 1. $K \geq 0$ is a target level of reserves at date 1, which we take to be constant throughout; it captures reasons for holding reserves other than the (short-run) fear of sudden stops we emphasize. Deviations from this target are costly: a shortfall from the target implies that the central bank's objectives cannot be adequately met. Similarly, an excess level of reserves implies accumulation costs (which, among other things, capture the difference between the borrowing and the lending rate and the slope of the yield curve). The term $1(\mathrm{SS})Z$ is composed of two terms: an indicator function, $1(\mathrm{SS})$, that becomes 1 during a sudden stop (SS) and is 0 otherwise, and a constant, $Z > 0$, that controls the need for funds during the sudden stop. This constant captures the shift in the marginal utility of wealth that occurs once a sudden stop takes place. Hence, by construction of the optimization problem, a central bank desires to transfer reserves to sudden stop states. The program of equation (1) is to be solved subject to

$$R_0 = \pi P_0 + B_0 \text{ and} \tag{2}$$

$$R_1 = B_1 + \pi P_1,$$

where R_1 is the initial level of reserves, π is the amount of risky securities held by the central bank, P_0 is the price of such securities, and P_1 is the (stochastic) payoff of these assets at $t = 1$. B_0 is the amount of noncontingent bonds held by the central bank, whose interest rate we fix at 0 for simplicity, so that $B_1 = B_0$ and

$$R_1 = R_0 + \pi(P_1 - P_0).$$

Replacing this expression in equation (1) and computing the first-order conditions with respect to R_0 and π yields

$$R_0 = K + \Pr(\mathrm{SS})Z \text{ and} \tag{3}$$

$$\pi = Z \frac{\mathrm{cov}\left[1(\mathrm{SS}), P_1\right]}{\mathrm{var}(P_1)}, \tag{4}$$

where we have removed Merton's portfolio term by assuming fair risk-neutral pricing of the risky asset (an assumption we maintain throughout):

$$E(P_1) = P_0 .$$

We highlight three observations about this simple setup at this stage. First, the central bank has an aversion to overaccumulating reserves. If $Z = 0$ and $K = 0$, then $R_0 = 0$. Under these circumstances, the central bank achieves the maximum of the objective. Our main concern in this paper is with those reserves associated with the possibility of a costly sudden stop, $Z > 0$.

Second, the level of reserves invested at date 0, R_0, is independent of the portfolio, π, or the properties of the risky asset. This is due to the so-called certainty-equivalence property of the quadratic model. With more general preferences that exhibit a prudence motive, such as a constant relative risk aversion (CRRA), an increase in hedging (π) reduces the total amount of reserves held (see Caballero and Panageas, 2005).

Third, and most importantly, risky assets are not held if P_1 is uncorrelated with the sudden stop, 1{SS}. Risky assets are only held to the extent that they succeed in creating attractive payoffs during sudden stops, that is, as long as[1]

$$E(P_1 | SS = 1) > E(P_1 | SS = 0).$$

2. From Conventional Reserves to Hedges

We now characterize the solution for three cases of special interest. The first—our base-case model—assumes away hedging completely, which is not far from what central banks do in practice. The second case is an Arrow-Debreu setup in which contracts can be written contingent on the sudden stop. It captures the opposite extreme. The third is an intermediate case that allows for proxy hedging through contracts that are correlated, but not perfectly, with sudden stops.

1. We have renormalized all potential assets to be held in positive amounts.

2.1 No Hedging

We set $\pi = 0$ in the base-case model and drop the optimization with respect to π. Then,

$$B_0 = R_0 = K + \Pr(SS)Z \,. \tag{5}$$

As one might expect, the possibility of a sudden stop induces the country to hold reserves beyond the target level, *K*. This is probably one the main reasons why Chile, for example, holds four to five times the reserves of Australia or Canada.

2.2 Hedging with Arrow-Debreu Securities

Taking the opposite extreme, assume that an asset pays

$$\begin{cases} 1 \text{ if } SS = 1 \\ 0 \text{ if } SS = 0 \end{cases}$$

In this case our assumption of fair-pricing implies that

$$P_0 = \Pr(SS) \,.$$

It follows from equation (4) and the fact that in this case

$$\operatorname{cov}\left[1(\mathrm{SS}), P_1\right] = \operatorname{var}\left[1(\mathrm{SS})\right] = \operatorname{var}(P_1)$$

that

$$\pi = Z \,. \tag{6}$$

When we replace this expression in equations (2) and (3), we obtain

$$B_0 = K + \Pr(SS)(Z - \pi) = K \,.$$

With perfect Arrow-Debreu securities (and fair pricing), the central bank will completely hedge away the sudden stop risk, so that

$$R_1 - 1(\mathrm{SS})Z = B_0 = K \,.$$

Now let us express the portfolio of Arrow-Debreu securities as a proportion of total reserves:

$$\phi = \frac{\pi P_0}{R_0} = \frac{\Pr(SS)Z}{K + \Pr(SS)Z} \,.$$

In the interesting special case of $K = 0$ (corresponding to the case in which the country finds it optimal to hold no reserves in the absence of sudden stops), we have

$$\phi = 1 .$$

That is, all resources are invested in Arrow-Debreu securities.

2.3 The Intermediate Case

In reality, one observes neither Arrow-Debreu securities nor contracts written contingent on the sudden stop (at least in an amount sufficient to insulate the country from it). There are good reasons for that: in practice, the sudden stop itself is unlikely to be fully contractible, since its occurrence may depend on a country's actions and private information. The practical relevance of the simple model proposed above thus rests critically on the existence of assets and trading strategies that could function as good substitutes for the idealized assets envisaged above. We develop a simple extension to the Arrow-Debreu world above by introducing an asset that pays 1 when an event that we call J happens (corresponding, for example, to a discrete drop in some asset price). We introduce the notation

$$\psi^h = \Pr\left(SS = 1 \middle| J = 1\right),$$

$$\psi^l = \Pr\left(SS = 1 \middle| J = 0\right),$$

$$\eta = \Pr\left(J = 1\right), \text{ and}$$

$$\psi^l = \Pr\left(SS = 1\right) = \eta\psi^h + \left(1 - \eta\right)\psi^l ,$$

and we assume that

$$0 \leq \psi^l \leq \psi^h \leq 1 .$$

In this case, it is suboptimal for the country to invest all of its assets in risky securities, but the country is generally willing to invest some, provided that

$$\psi^h > \psi^l .$$

The new optimization problem yields

$$\pi = Z\frac{(\psi^h - \psi)}{(1-\eta)} = Z(\psi^h - \psi^l) \text{ and} \tag{7}$$

$$B_0 = K + \psi Z - \pi\eta .$$

These formulas encompass those obtained previously. If $\psi^h = \psi^l$, then the two indicators are independent and thus $\pi = 0$. However, as $\psi^h \to 1$ and $\psi^l \to 0$, then $\psi \to \eta$ and the country insures the sudden stop completely. Short of that, the central bank finds it optimal to hedge sudden stops partly with noncontingent reserves: if $\psi^h < 1$, the risky asset may not deliver during a sudden stop. And if $\psi^h < 1$ $\psi^l > 0$, the country pays for protection it does not need from the risky asset.[2]

As a percentage of total reserves, the risky asset portfolio represents

$$\phi = \frac{\pi P_0}{R_0} = \frac{Z\eta}{R_0}(\psi^h - \psi^l).$$

This expression has a natural interpretation. Let $x \in [0, 1]$ represent the share of reserves allocated to the prevention of sudden stops in the near future:

$$x = \frac{\psi Z}{K + \psi Z} .$$

Given quadratic utility, this number is independent of the hedging instruments (the properties of J do not influence this number). Then the optimal portfolio is as follows:

$$\phi = x\frac{\eta}{\psi}(\psi^h - \psi^l). \tag{8}$$

That is, the portfolio is composed of three terms. The first is the fraction of reserves used for the prevention of sudden stops, x.[3] The second

2. With quadratic utility it suffices that $\psi^l = 0$ and $\psi^h > 0$ for the country to invest its entire portfolio in the risky asset (for $K = 0$). The proximity of ψ^h to one only determines how much hedging is achieved by this strategy.

3. Our sense of prevention is different from that in García and Soto (in this volume), where a stock of reserves is needed to prevent runs on the country. Their concept is subsumed in our fixed K, although if runs are related to factors that tighten international financial markets, then this term also should be analyzed as an optimal portfolio decision.

captures the relative frequency of jumps and sudden stops; as this rises, the price of the insurance rises. The third is the difference between the probability of a jump conditional on a sudden stop taking and not taking place. The latter term captures the risky asset's ability to transfer resources to the states where they are needed the most.

Dividing ϕ by x isolates the share of the risky asset in the component of reserves used for hedging sudden stops. This is the concept we emphasize henceforth by setting $x = 1$ (or $K = 0$).

3. Implementation Issues

This section takes the analysis one step closer to actual assets. We start by specifying a state variable, s_t, that is correlated with sudden stops but is not under the country's control. Assume that s_t evolves according to the following discretized stochastic differential equation:

$$s_{t+1} - s_t = \mu(s_t)\Delta t + \sigma N(0,1)\sqrt{\Delta t} + \varepsilon dJ_1, \qquad (9)$$

where $\mu(s_t)$ is the drift (that is, the mean appreciation rate of the state variable) and σ is the volatility. The most interesting part of this expression is the jump process, dJ_1, which is zero except at date 1, when it takes the value one with probability η and zero otherwise, in perfect analogy to the setup in the last section. We let ε be a normally distributed random variable, with mean $\mu_\varepsilon > 0$ and standard deviation σ_ε.

3.1 Call Options

Given the above framework, we develop a simple strategy that can create an asset of the sort envisaged in section 2.3 by writing contracts contingent on s_t. To do this, we take the continuous time limit of equation (9) and consider a contract with an investment bank or insurer in which the central bank pays an amount, κdt, in exchange for each dollar received if s_t exhibits a jump at $t = 1$. Such a contract is well defined in continuous time. In reality, we can approximate it by signing a sequence of appropriate (sufficiently out-of-the-money) digital options that cost ηdt per unit of time. Such options can also be well approximated by regular puts and calls. The cost of such a position over the full period is

$$\int_0^1 \eta dt = \eta,$$

and the payoff is one if a jump happens at $t = 1$, and zero otherwise. This strategy is also feasible if one extends the model to the case in which a jump in s_t can happen at any time τ, as in Caballero and Panageas (2005). This is the process we estimate in the empirical section.

In conclusion, this sequence of short term digital options is, for all practical purposes, identical to the contract described in section 2.3.[4]

3.2 Futures Contracts

We now consider simple futures contracts. If investors are risk neutral with respect to s_t risk, a futures contract on s_t with maturity at $t = 1$ can be entered into at a forward price of

$$E(s_1),$$

with return

$$s_1 - E(s_1 | s_0).$$

The expected payoff of such a position at $t = 1$ is approximately[5]

$$\tilde{v} \sim N(-\eta\mu_\varepsilon, \sigma) + 1(J)N(\mu_\varepsilon, \sigma_\varepsilon),$$

where $1(J)$ corresponds to an indicator function that takes the value of one when a jump in the state variable takes place, and zero otherwise.

Futures have a price of zero. To keep the analysis comparable with the results obtained in section 2.3, however, we consider a slight variation of a futures contract and assume that the country must pay $\eta\mu_\varepsilon$ upfront for every contract into which it enters in exchange for a payoff of

$$v \sim N(0, \sigma) + 1(J)N(\mu_\varepsilon, \sigma_\varepsilon).$$

The solution to the maximization problem of equation (1) in this case is thus

$$\pi\mu_\varepsilon = Z\frac{\psi^h - \psi}{\left[(\sigma^2 + \eta\sigma_\varepsilon^2)/\eta\mu_\varepsilon^2\right] + 1 - \eta} = Z\frac{1 - \eta}{\left[(\sigma^2 + \eta\sigma_\varepsilon^2)/\eta\mu_\varepsilon^2\right] + 1 - \eta}(\psi^h - \psi^l);$$

$$B_0 = K + \psi Z - \pi\eta\mu_\varepsilon.$$

4. See Caballero and Panageas (2005) for a more extensive discussion of these issues.

5. A continuous time model is necessary to make the argument in this section exact.

Several observations about π are worth highlighting. First, we can set $\mu_\varepsilon = 1$ without loss of generality, since the dollar amount invested in the risky asset is $\pi\mu_\varepsilon$ at a price of η per dollar invested. Moreover, the right-hand side depends only on the ratios (σ/μ_ε) and $(\sigma_\varepsilon/\mu_\varepsilon)$. Hence from now on, we set $\mu_\varepsilon = 1$ and denote

$$\tilde{\sigma} = \frac{\sigma}{\mu_\varepsilon},$$

and similarly for $\tilde{\sigma}_\varepsilon$ and $\tilde{\pi}$. Thus, in dollar amounts we have

$$\tilde{\pi} = Z\left(\psi^h - \psi^l\right)\frac{1-\eta}{\left(\tilde{\sigma}^2/\eta\right) + \tilde{\sigma}_\varepsilon^2 + 1 - \eta}. \tag{10}$$

Comparing equations (10) and (7) shows that the amount invested in risky assets declines when one moves from digital options on the jump to simple futures (that is, the denominator is larger in equation (10)). The ratio between the two portfolios is

$$\frac{1-\eta}{\left(\tilde{\sigma}^2/\eta\right) + \tilde{\sigma}_\varepsilon^2 + 1 - \eta} < 1, \tag{11}$$

which declines as $\tilde{\sigma}$ and $\tilde{\sigma}_\varepsilon$ increase. This is intuitive: the more noise contained in the hedging opportunities, the less appealing they become to a risk-averse central bank. The portfolio ϕ is also attenuated by the ratio in equation (11).

To summarize, sudden stops must be severe to justify adding a risky asset to the central bank's holdings, and the risky asset must be sufficiently correlated with such events. On the other hand, neither causality nor the predictability of sudden stops and returns are part of the argument for a non-zero π.

4. Quantitative Assessment

The theoretical argument for hedging is difficult to dispute. The relevant question is thus an empirical one: do some global financial instruments and indices offer good enough hedging opportunities against sudden stops? The answer to this question is largely country specific, as not all emerging market economies are exposed to the same sources of fragility. In this section, rather than performing a collection of case studies, we show that at least one global asset has significant correlation with emerging market crises. In the absence of better country-specific alternatives, this global asset should constitute a significant share of these countries' portfolios.

4.1 The Basics: Sudden Stops and Jumps

We study a group of nine emerging market economies open to international capital markets in the 1990s, for which we have complete data: Argentina, Brazil, Chile, Indonesia, Korea, Malaysia, Mexico, Thailand, and Turkey.[6] These economies are representative of what is often referred to as emerging market economies. Our main exclusion is the group of Eastern and Central European economies, which became significant participants in international capital markets in the second half of the 1990s. These countries, however, faced economic problems of a somewhat different nature during much of our sample.

The first point to highlight is the well known fact that private capital flows to these economies comove significantly. Figure 1 splits into two panels the paths of the change in capital flows—more precisely, the difference between contiguous four-quarter moving averages of quarterly capital flows—to each of these economies from 1992 to 2002. The shaded areas mark the periods corresponding to the systemic tequila crisis, Asian crisis, and Russian crisis, as well as the sequence of somewhat less systemic Turkish, Argentine, and Brazilian crises. The figure demonstrates that these flows correlate significantly, especially within regions. Turkey is somewhere in between the two regions. These comovements are encouraging, as they indicate the possibility of finding global factors correlated with sudden stops.

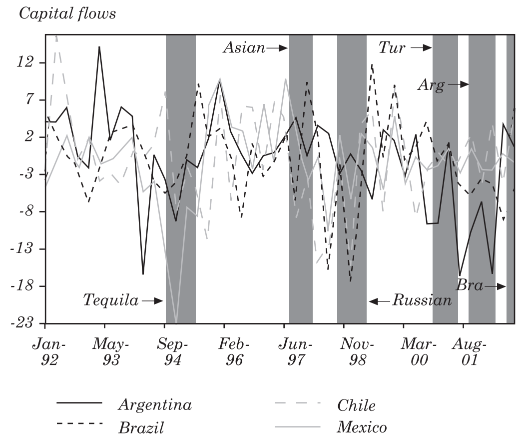
The second, and main, point is that clearly identifiable global factors—in fact, traded factors—are correlated with emerging market sudden stops. The key to finding such factors is that these episodes are generally understood as times when investors are reluctant to participate in risky markets. The VIX precisely captures this reluctance, and it has been available in the United States since 1986. This is an index of the implied volatilities from puts and calls (typically eight) on the S&P 100.[7] Figure 2 reproduces the shaded areas for

6. The exception is Malaysia, for which we do not have quarterly capital flows.

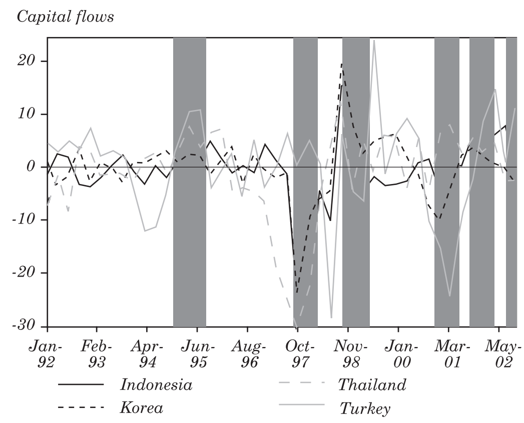
7. Implied volatilities are determined using the Black and Scholes (1973) formula to calculate the level of volatility that would be compatible with the observed prices of puts and calls.

Figure 1. Capital Flows for Varius Countries[a]

A. Capital flows for Latin American countries



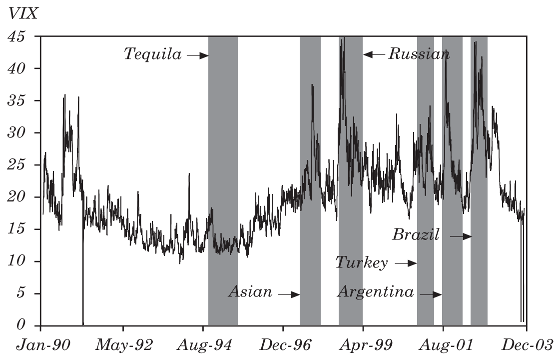
B. Capital flows for East Asian countries and Turkey



Source: International Financial Statistics (IFS).
a. The figure depicts the difference between four-quarter averages of capital flows and the same quantity one year before. The shaded areas depict periods of major crises).

sudden stops described in the previous graph and plots the daily VIX. Some of the largest jumps in the VIX occur precisely during sudden stops. In fact, the only systemic sudden stop that does not coincide with a jump is the tequila crisis, when the rise in the VIX was not large enough to count as a distinct jump.

Figure 2. Daily VIX Series[a]



Source: Chicago Board of Options Exchange (CBOE).
a. The shaded areas depict the periods of major crises.

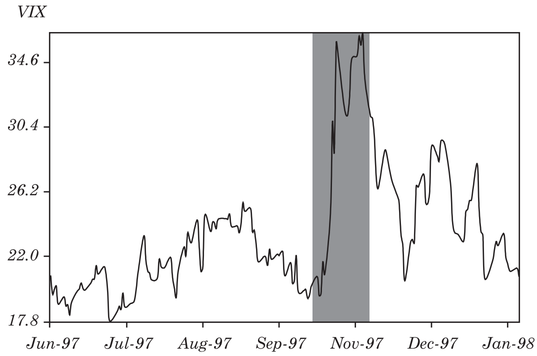
The next section formally documents the joint behavior of sudden stops and jumps in the VIX. First, however, we explore the behavior of the VIX during the two largest systemic crises of the 1990s (namely, the Asian and Russian crises). The top panel in figure 3 plots the path of the VIX during the last two weeks of October 1997 (that is, the onset of the Asian Crisis), while the bottom panel does the same for August–September 1998 (the peak of the Russian long-term capital management crisis). In these events, the VIX reached levels above 30 and 45 percent, respectively, which are close to the maximum levels of the index. The VIX doubled in a matter of days.

Finally, figure 4 reinforces the message of high correlation by plotting the path of the VIX together with J.P. Morgan's Emerging Market Bond Index (EMBI) for three of the most fragile emerging markets in recent years: Argentina, Brazil, and Turkey. The dips in the EMBIs correspond with the sharp rises in the VIX.[8] The VIX—a variable that is primarily meant to capture the "feelings" of investors in U.S. equity markets—thus happens to be highly correlated with the fortunes of emerging market economies. This highlights another important aspect of our methodology, according to which the only requirement for a variable like the VIX to be useful in hedging is that there also be a change in the conditional probability of having a crisis in emerging markets. This is not a statement about causation, but about correlation.

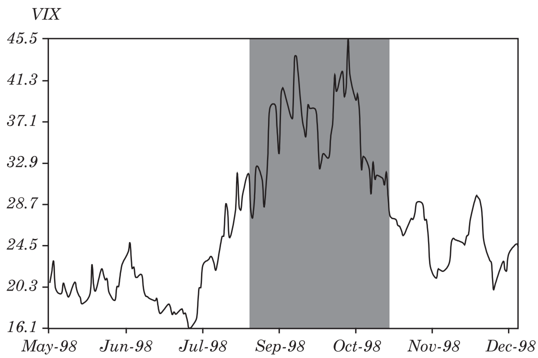
8. The EMBI data are from Datastream. Note that the Argentine (permanent) crash also coincides with a spike in the VIX.

Figure 3. Plots of the VIX in the Weeks Surrounding Major Crises in International Financial Markets

A. Daily VIX during the Asian crisis



B. VIX Daily during the Russian crisis



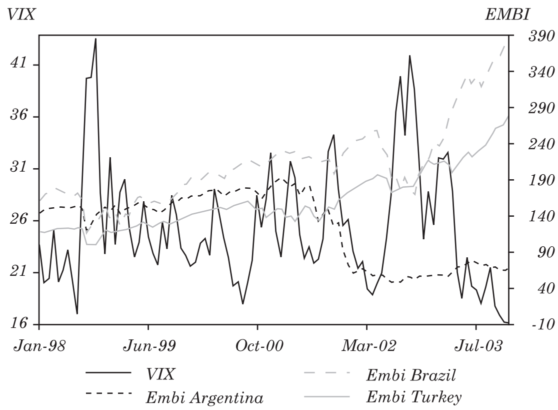
Source: Chicago Board of Options Exchange (CBOE).

We are not claiming that domestic factors do not play a paramount role in crises. Quite the contrary, we chose Argentina, Brazil, and Turkey for the previous figure precisely because their own domestic weaknesses make them more responsive to global factors. This compounding effect often raises, rather than dampens, the need for hedging global risk factors.

4.2 Quantification

We now turn to a structural analysis of the correlations highlighted above.

Figure 4. The VIX and the EMBI for Argentina, Brazil, and Turkey



Sources: CBOE and Datastream.

Estimation of the VIX process

To operationalize the model of the previous section, we take log(VIX) to be the state variable, s_t, which follows the continuous time process,

$$ds_t = -\theta\left[\log(s_t) - y\right]dt + \sigma dB_t + \varepsilon dJ_t\,.$$

This is the continuous time limit of equation (9), with the modification that jumps can happen at any point in time.[9] The functional form,

$$\mu(s_t) = -\theta\left[\log(s_t) - y\right],$$

corresponds to a first-order autoregressive, or AR(1), process in discrete time for log(s_t). We thus start by estimating an AR(1) process for log(VIX) with monthly data and focus on the residuals, v, which are distributed (for small Δt) roughly as

$$v \sim (1-p)N\left(-\eta\mu_\varepsilon\Delta t, \sigma\sqrt{\Delta t}\right) + pN(\mu_\varepsilon, \sigma_\varepsilon).$$

9. This is not a serious departure if the horizon in the decision model is understood to be one year and the probability of more than one jump taking place in a single year is small.

Given the very few observations with jumps, we identify these directly by inspection; this process fixes $\eta = 0.417$ and hence $p = 1 - e^{-\eta\Delta t}$. The rest of the parameters are estimated by maximum likelihood of the mixing of two normal distributions, with the following results: $\mu_{\varepsilon} = 0.356$; $\sigma = 0.353$; and $\sigma_{\varepsilon} = 0.047$.

The likelihood of sudden stops

The results in the previous section suggest the presence of seven jumps in the VIX in our sample: the first Persian Gulf War, the Asian crisis, the Russian crisis, the terrorist attacks on the United States (9/11), the Turkish crisis, the Brazilian crisis, and the corporate scandals in the United States. Conditional on these jumps, we calculate the probability that a country will experience a sudden stop. We identify an observation as a sudden stop based on a mixture of information on capital flow reversals and reserve losses (see Caballero and Panageas, 2005). Mainly, for an observation to count as a sudden stop, capital flows must decline by at least 5 percent of gross domestic product (GDP) relative to the flows in the previous two years, and reserves must be declining. This procedure yields estimates of ψ^h and ψ^l for each country. We then estimate ψ from the relation

$$\psi = \eta\psi^h + (1-\eta)\psi^l .$$

The results are reported in Table 1. The country-specific estimates are highly imprecise, however, as they correspond to the product of binary variables with very few transitions in each case.[10] We therefore pool the observations, which yields the results for the sample average. We also report results for two subcategories: high-risk economies (Argentina, Brazil, and Turkey) and the East-Asian economies. The former group is composed of the economies that have the highest estimated likelihood of a sudden stop in the sample.

10. The case of Mexico is particularly revealing. The estimate of $\psi^h = 0$ misses the fact that while Mexico did not experience a very significant capital flow reversal during the Russian/LTCM/Brazilean turmoil, its stock market declined very sharply, reflecting that it experienced significant pressure at the time, but adjusted primarily via prices instead of quantities. Chile and the East Asian countries have a $\psi^l = 0$ because we identify only a single SS for each of them and we observe a jump in the VIX during the same period.

Table 1. Estimates for ψ, ψ^h, and ψ^l

Country or group	ψ	ψ^h	ψ^l
Argentina	0.42	0.80	0.14
Brazil	0.42	0.60	0.29
Chile	0.17	0.40	0.00
Indonesia	0.17	0.40	0.00
Korea	0.08	0.20	0.00
Malaysia	0.25	0.40	0.14
Mexico	0.17	0.00	0.29
Thailand	0.17	0.40	0.00
Turkey	0.33	0.60	0.14
Average	0.24	0.41	0.11
High-risk countries	0.39	0.67	0.19
East Asia	0.17	0.35	0.04

Source: Authors' calculations.
a. ψ^h is estimated as the number of years in which we observe a joint jump in the VIX and a sudden stop in the country, divided by the number of jumps in the VIX. Symmetrically, ψ^l is the ratio of the number of years in which a sudden stop was not accompanied by jump, divided in the total number of years without a jump. To determine whether a sudden stop and a jump coincide, we allow for a two-quarter window around the date of the identified jump, because jumps are identified at a higher frequency than sudden stops. With the estimates for η, ψ^l, and ψ^h in hand, we obtain the estimate for ψ presented in the first column of the table.

The pooled estimate indicates that an average emerging market economy is nearly four times more likely to experience a crisis when the VIX has jumped than when it has not. Again, this is not a statement of causation, but of correlation. When the VIX spikes, the average emerging market economy has a 41 percent chance of experiencing a sudden stop. This chance drops to 11 percent when the VIX is tranquil.

Representative VIX portfolios and reserves gains

We use the above numbers to operationalize formulas 8 and 11 and thus estimate the portfolios implied by the model. Again, country-specific numbers are very imprecise, so attention should be placed on the pooled results. Table 2 reports the portfolios.

The values of ϕ are large. The futures contracts show shares of risky assets of 10 percent or higher for the different groupings, despite the large amount of noise in the VIX. When the call-options strategy is followed and hence the "noise" is removed, the shares rise to above 50 percent in all cases, and to nearly 80 percent for the Asian economies. The share is high among East Asian economies because in the sample, they experience mainly systemic crises (again, this is not a causal

Table 2. Representative Portfolios for Options and Futures

Country	ϕ *(Options)*	ϕ *(Futures)*
Argentina	0.66	0.13
Brazil	0.31	0.06
Chile	1.00	0.20
Indonesia	1.00	0.20
Korea	1.00	0.20
Malaysia	0.43	0.08
Mexico	0.00	0.00
Thailand	1.00	0.20
Turkey	0.57	0.11
Average	0.53	0.10
High-risk countries	0.51	0.10
East Asia	0.79	0.16

Source: Authors' calculations.

statement); this contrasts with the high-risk economies, which also experience idiosyncratic crises.[11]

These portfolios are dramatically different from those normally held by central banks in emerging markets. Finding out why seems imperative. Is it the potential markets' lack of liquidity, domestic political constraints, or simple institutional herding?

5. The Benefits

Our reduced-form portfolio model is not well suited for a thorough welfare comparison. In assessing the benefits of the hedging strategy, we thus focus on statistics that are robust across preferences. In particular, we report the expected gains conditional on the occurrence of a sudden stop. We illustrate this for the call-options scenario.

The first step in computing this statistic is to estimate the likelihood of a jump given that the country has experienced a sudden stop. Using Bayes' rule yields

$$\Pr\left(J = 1 \middle| SS = 1\right) = \psi^{h} \frac{\eta}{\psi} .$$

11. Note also that the difference between the optimal precautionary behavior of a high risk and an average economy is not only reflected in the different values for ϕ, but also on the level of reserves held. Recall that $R_0 = K + \psi Z$.

Table 3. Revised Probabilities and Expected Gains When Following the Options Strategy

Country	*Pr*(J = *1 ½ SS = 1)*	Expected gain (options)
Argentina	0.80	0.60
Brazil	0.60	0.14
Chile	1.00	1.40
Indonesia	1.00	1.40
Korea	1.00	1.40
Malaysia	0.67	0.26
Mexico	0.00	0.00
Thailand	1.00	1.40
Turkey	0.75	0.46
Average	0.72	0.39
High-risk Countries	0.71	0.36
East Asia	0.88	0.86

Source: Authors' calculations.

Table 3 reports the estimates, which are around 70 percent for an average emerging market economy and close to 90 percent for the relatively stable East Asian economies. This is important. The VIX jumps with a high likelihood at times when the countries need it to do so.

The rate of return for the call strategy is

$$\begin{cases} 1/\eta - 1 & \text{if } J = 1 \\ -1 & \text{if } J = 0 \end{cases}$$

and the expected gain in reserves conditional on entering a sudden stop is thus

$$\phi\left[\psi^h \frac{\eta}{\psi}\left(\frac{1}{\eta}-1\right)-\left(1-\psi^h \frac{\eta}{\psi}\right)\right].$$

Table 3 also reports these results. For an average economy, the expected gain is around 40 percent. That is, an average economy following the strategy described here can expect a 40 percent rise in its reserves on entering a sudden stop.[12] This is a significant number, which exceeds the actual reserve losses of many of these economies during their respective sudden stops.

12. The counterpart of this expected gain during sudden stops is that the economy may expect to lose 13 percent of its reserves when there is no sudden stop.

Many caveats can be raised here, and they are likely to reduce these large numbers. For example, in a dynamic model, the central bank might find it optimal to hold a level of reserves above a certain minimum in all contingencies, even in good states. In the present model, this is equivalent to assuming that the central bank targets a nonzero level of reserves (that is, $K > 0$), which implies that $x < 1$. As shown in expression 8, the portfolio of risky assets is scaled down proportionally with x. Alternatively, one could imagine a situation in which a central bank wishes under no circumstances to lose more than c percent of its reserves, in which case the optimal portfolio would become

$$\min(c, \phi) .$$

Notwithstanding these caveats, the above calculations make a simple point: no matter which assumptions we make about preferences and constraints, the driving force behind our results is the strong correlation between the VIX index and the incidence of sudden stops. The simple quadratic framework that we propose is particularly well suited to making this separation between preferences (which solely affect x) and correlation explicit. While a more elaborate model like that in Caballero and Panageas (2005) is required to develop a satisfactory theory for x, the effects that come from the strong correlations are independent of the specifics of the model.

6. Final Remarks

We start our conclusion with a disclaimer. The portfolios we illustrate for the emerging market economies we study, and our emphasis on the VIX, are neither country-specific nor instrument-specific recommendations. Our goal is simply to illustrate the potential benefits of enriching the portfolio options of central banks and searching for assets and indices that are global in nature but correlated with capital flow reversals.

Within this limited goal, our results are promising: the expected gains in reserves during sudden stops can be significant (slightly less than 40 percent of reserves for an average country). This is noteworthy, considering that we are only considering a single risky asset which is not optimized to capture the risks faced by emerging market economies.

The latter point raises an issue of international financial architecture. The VIX is useful because it is correlated with implied volatilities and risks in emerging markets, but it also captures problems that are specific to the United States. Ideally, one would want an index that weights U.S. events that are likely to have worldwide systemic effects differently from those that are not. It should be relatively easy to construct implied volatility indices that isolate the former factors and still preserve the country-exogeneity properties of the VIX. Constructing such indices is important for creating benchmarks and developing liquid hedging markets for economies exposed to capital flow volatility.

An issue that we avoided entirely is the incentive effects that a modified central banks' policy of hedging external shocks may have on the private sector. This is an important concern, since the private sector may undo some of the external insurance in anticipation of a central bank's intervention. The hedging policy should probably be coordinated with monetary and regulatory policies (see Caballero and Krishnamurthy, 2003). Even in the absence of these complementary policies, however, perverse incentive effects are unlikely to be strong enough to fully offset the justification for more aggressive hedging practices. After all, current reserve policies also suffer from these problems and are justified on the grounds that many in the private sector are simply not forward-looking enough to hedge aggregate risks in sufficient amount.

If such practices were to be adopted collectively, we would soon observe the emergence of new instruments that better match the needs of emerging market economies. The welfare improvement from such enhancements could be very significant and therefore may justify a coordination role by the international financial institutions and central banks around the world. Such coordination may be a necessity for limiting the potential political costs from hedging losses.

To conclude, we reiterate that our emphasis on external sources of capital flow volatility does not seek to shift the blame for much of capital flow volatility away from the countries themselves. Our goal is simply to show that a significant component can be hedged. Moreover, the issue we highlight here interacts with the domestic sources of external fragility: weak countries are more likely than strong countries to be hit by global turmoil, and they should therefore put an even bigger effort into hedging against these global shocks.

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