# Is the Foreign Exchange Derivatives Market Effective and Efficient in Reducing Currency Risk?

Esteban Jadresic
*Central Bank of Chile*

Jorge Selaive
*Central Bank of Chile*

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

We thank our discussant Guillermo Larraín and seminar participants at the *Encuentro de la Sociedad de Economía de Chile* and the *Third Workshop on Emerging Markets* held in Madrid. We also thank Felipe Alarcón and Paulina Rodríguez for research assistance. The views expressed here are those of the authors and do not necessarily reflect the positions of the Central Bank of Chile.

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

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.

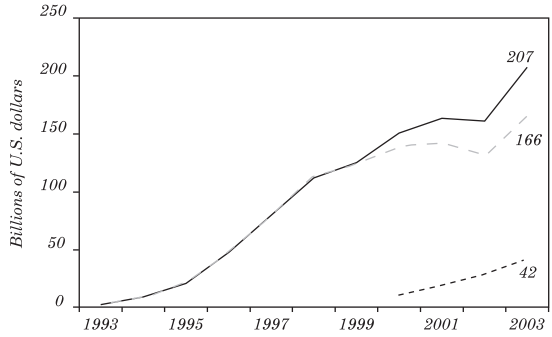
## 1. Characteristics of the Derivatives Market in Chile

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

| | Quoted forward spreads, 30 days | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Country* | *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 |

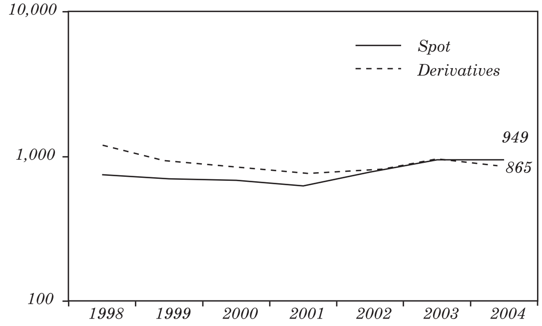
Source: Authors´ calculations based on data from Bloomberg.
a. Volatility measured by the standard deviation of the spread first difference.

## 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.

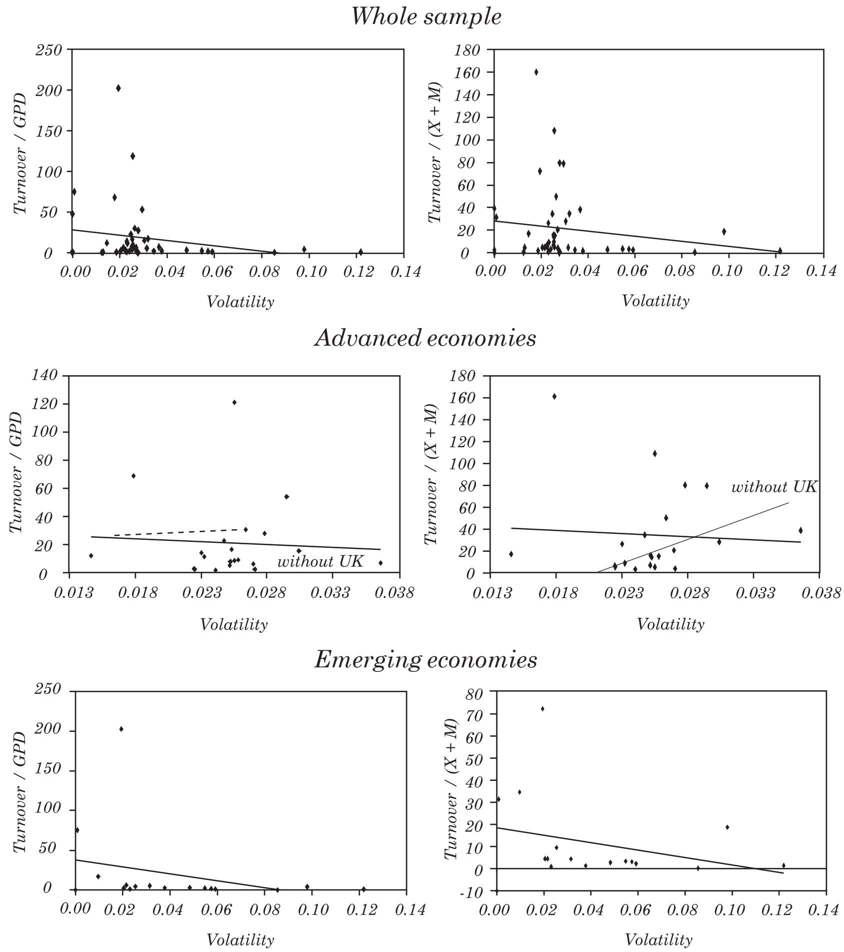
## 2. The Foreign Exchange Derivatives Market and the Volatility of the Spot Exchange Rate

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:

$$\begin{aligned} \mathrm{VOL}_i = {} & \beta_0 + \beta_1 \mathrm{OPEN}_i + \beta_2 \mathrm{FIN\_DEV}_i + \beta_3 \mathrm{SIZE}_i \\ & + \beta_4 \mathrm{GDP\_PC}_i + \beta_5 \mathrm{DERIV}_i + \mu_i , \end{aligned}$$

where $\mathrm{VOL}_i$ 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<br>(0.004) | 0.007<br>(0.004) | 0.003<br>(0.005) | 0.009<br>(0.007) |
| Financial development | –0.011***<br>(0.003) | –0.007***<br>(0.003) | –0.010***<br>(0.003) | –0.009**<br>(0.004) |
| Size | 0.003***<br>(0.001) | 0.004***<br>(0.001) | 0.004**<br>(0.001) | 0.005***<br>(0.001) |
| GDP per capita | | –0.004*<br>(0.002) | | –0.005*<br>(0.003) |
| Derivatives usage | –0.011<br>(0.001) | –0.001<br>(0.001) | –0.001<br>(0.001) | –0.001<br>(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.

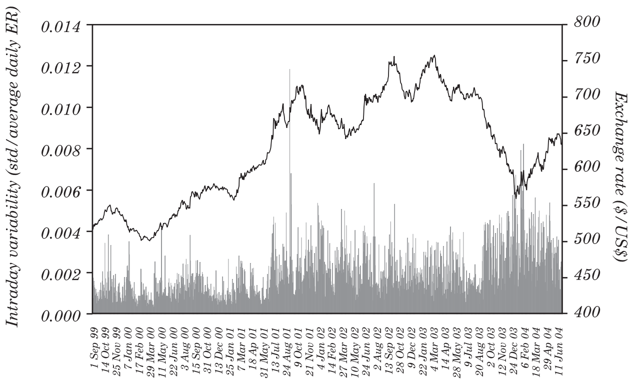
**Table 10. Volatility–Activity Relation: Specification B[a]**

| *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. $\text{Activity}_t = a + b\text{Activity}_{t-1} + g\text{Volatility}_t + d\text{Trend} + e_t$. 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* | | |
| $\text{Temporary}_t$ | 0.000 | no |
| $\text{Temporary}_{t-1}$ | 0.052 | no |
| *Nonbank domestic agents with foreign clients* | | |
| $\text{Temporary}_t$ | –0.049 | no |
| $\text{Temporary}_{t-1}$ | –0.129 | no |
| *Banks with pension funds* | | |
| $\text{Temporary}_t$ | 0.160 | yes |
| $\text{Temporary}_{t-1}$ | 0.211 | yes |
| *Banks with the nonbank financial sector* | | |
| $\text{Temporary}_t$ | –0.004 | no |
| $\text{Temporary}_{t-1}$ | –0.004 | no |
| *Banks with the nonfinancial sector* | | |
| $\text{Temporary}_t$ | 0.097 | no |
| $\text{Temporary}_{t-1}$ | 0.016 | no |
| *Banks with other domestic agents* | | |
| $\text{Temporary}_t$ | 0.096 | no |
| $\text{Temporary}_{t-1}$ | 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:

$$\mathrm{VOL}_t = \alpha_0 + \alpha_1 \mathrm{TEMP}_t^i + \alpha_2 \mathrm{VOL}_{t-1} + \varepsilon_t \quad \text{and} \tag{1}$$

$$\mathrm{TEMP}_t^i = \alpha_0 + \alpha_1 \mathrm{VOL}_t + \alpha_2 \mathrm{TEMP}_{t-1}^i + \breve{i}_t\,, \tag{2}$$

where $\mathrm{TEMP}^i$ 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* | $\alpha_1$ | $\beta_1$ | $\alpha_1$ | $\beta_1$ |
| Banks with foreign clients | $-2.3\text{x}10^{-7}$<br>$(2.2\text{x}10^{-7})$ | 3813.4<br>(3879.9) | $-2.2\text{x}10^{-7}$<br>$(2.5\text{x}10^{-7})$ | 2958.5<br>(3800.9) |
| Nonbank domestic agents with foreign clients | $-9.8\text{x}10^{-8}$<br>$(1.2\text{x}10^{-7})$ | –3225.1<br>(7942.9) | $-9.5\text{x}10^{-8}$<br>$(1.3\text{x}10^{-7})$ | –2490.7<br>(7774.9) |
| Banks with pension funds | $2.5\text{x}10^{-7}$<br>$(2.5\text{x}10^{-7})$ | 510.79<br>(2683.66) | $2.8\text{x}10^{-7}$<br>$(1.9\text{x}10^{-7})$ | 404.84<br>(2266.73) |
| Banks with the nonbank financial sector | $3.5\text{x}10^{-9}$<br>$(6.9\text{x}10^{-8})$ | –2788.7<br>(9557.4) | $1.6\text{x}10^{-9}$<br>$(7.0\text{x}10^{-8})$ | –6510.2<br>(9137.9) |
| Banks with the nonfinancial sector | $1.4\text{x}10^{-8}$<br>$(1.4\text{x}10^{-7})$ | 5951.9<br>(3901.8) | $2.3\text{x}10^{-8}$<br>$(1.3\text{x}10^{-7})$ | 5349.3<br>(4160.1) |
| Banks with other domestic agents | $3.5\text{x}10^{-8}$<br>$(7.4\text{x}10^{-8})$ | 7822.9<br>(10164.0) | $3.7\text{x}10^{-8}$<br>$(6.7\text{x}10^{-8})$ | 7822.9<br>(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]**

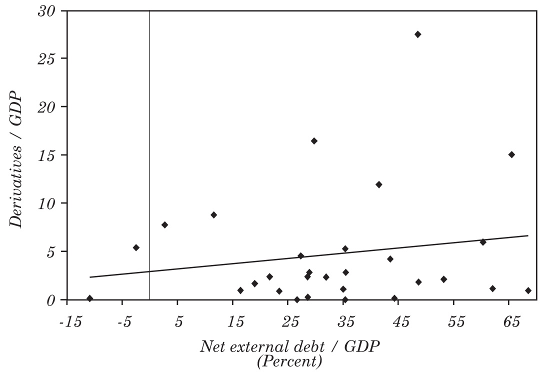
| *Country* | *Net foreign debt / GDP(percent)* | *Net foreign debt / (X + M)(percent)* | *Derivatives 2001/GDP* |
|---|---|---|---|
| Argentina | 35 | 106 | $10^{-3}$ |
| Australia | 49 | 147 | 27 |
| Austria | 35 | 50 | 5 |
| Brazil[b] | 44 | 183 | 4 |
| Canada | 41 | 60 | 12 |
| Chile | 29 | 54 | 2 |
| Colombia | 29 | 95 | $2 \times 10^{-1}$ |
| 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.

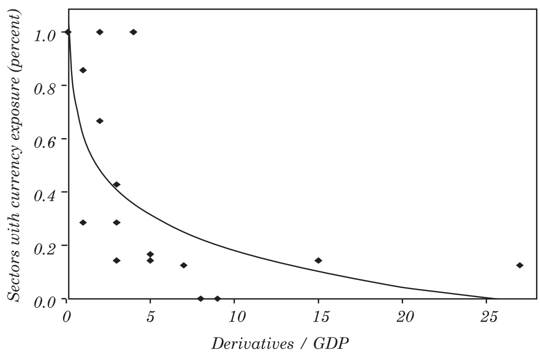
**Table 14. Exposure by Regression Analysis for Selected Countries[a]**

| *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:

$$\text{NET\_POS}^{D}_{j,t} = \sum \begin{bmatrix} \text{Purchases}_{i,t} - \text{Sales}_{i,t} \\ -\left(\text{Expired Purchases}_{i,t} - \text{Expired Sales}_{i,t}\right) \end{bmatrix}.$$

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:

$$\Delta \log(\text{NER})_{t+1} = \alpha_1 + \alpha_1 x_t + \varepsilon_{t+1} ,$$

which will improve forecast accuracy relative to the random walk forecast:

$$\Delta \log(\text{NER})_{t+1} = \alpha_1 + \varepsilon_{t+1} .$$

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 $\beta$ 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:

$$\text{NET\_POS}_t^S = \sum \left(\text{Purchases}_{i,t} - \text{Sales}_{i,t}\right).$$

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.

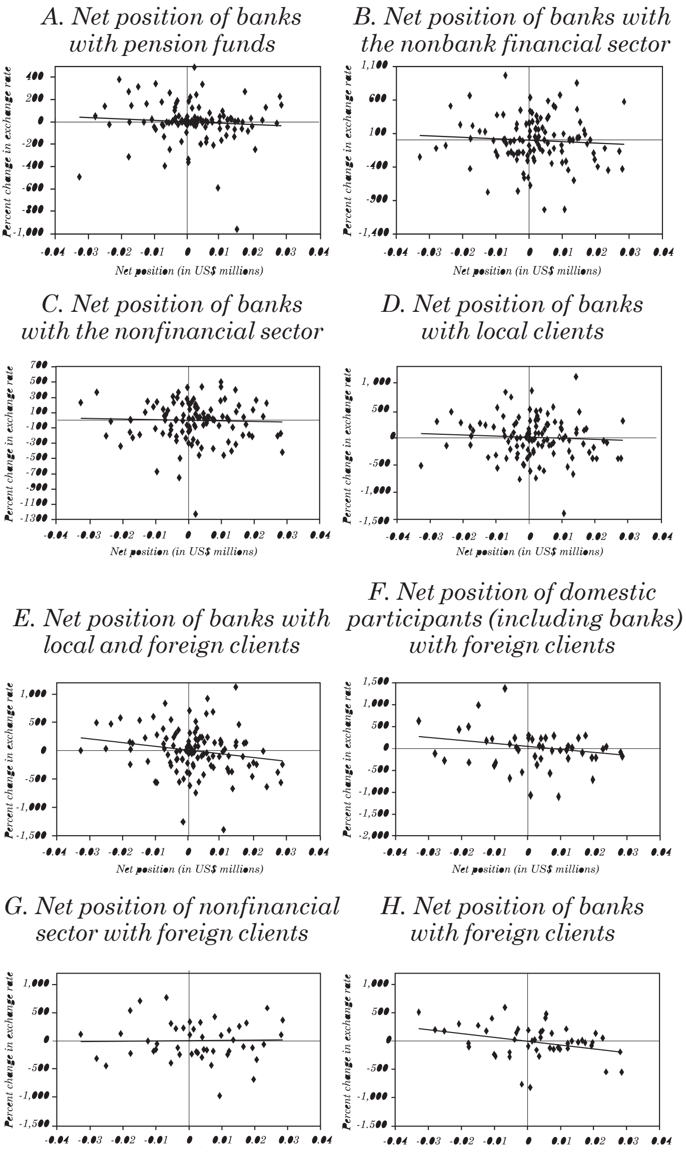
**Table 15 . Forecast Performance: Derivatives Market**

| | | *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).

## References


Alarcón, F., J. Selaive, and J. M. Villena. 2004. "El mercado de derivados cambiarios." Serie de estudios económicos 44. Santiago: Central Bank of Chile.

Allayannis, G. and E. Ofek. 2001. "Exchange Rate Exposure, Hedging, and the Use of Foreign Currency Derivatives." *Journal of International Money and Finance* 20(2): 273–96.

Bank for International Settlements. 1999. "Triennial Central Bank Survey: Foreign Exchange and Derivatives Market Activity, 1998." Basel.

————. 2002. "Triennial Central Bank Survey: Foreign Exchange and Derivatives Market Activity in 2001." Basel.

Bessembinder, H. and P. Seguin. 1992. "Futures-Trading Activity and Stock Price Volatility." *Journal of Finance* 57(5): 2015–34

Brorsen, B.W. 1991. "Futures Trading, Transactions Costs and Stock Market Volatility." *Journal of Futures Markets* 11: 153–63.

Caballero, R., K. Cowan, and J. Kearns. 2004. "Fear of Sudden Stops: Lessons from Australia and Chile." Working paper 04-23. Massachusetts Institute of Technology.

Cornell, B. 1981. "The Relationship between Volume and Price Variability in Futures Markets." *Journal of Futures Markets* 1(3): 303–16.

Danthine, J. 1978. "Information, Futures Prices, and Stabilizing Speculation." *Journal of Economic Theory* 17(1): 79–98.

Devereux, M. and P. Lane. 2002. "Understanding Bilateral Exchange Rate Volatility." Discussion paper 3518. London: Centre for Economic Policy and Research.

Dominguez, K. and L. Tesar. 2001. "A Reexamination of Exchange Rate Exposure." *American Economic Review* 9 (May, *Papers and Proceedings, 2000*): 396–99.

Evans, M. and R.K. Lyons. 2002. "Order Flow and Exchange Rate Dynamics." *Journal of Political Economy* 110(1): 170–80.

————. 2004. "A New Micro Model of Exchange Rate Dynamics." Working paper 10379. Cambridge, Mass.: National Bureau of Economic Research.

Fernández, V. 2001. "The Derivatives Market in Latin America with Emphasis on Chile." Working paper. Santiago: Universidad de Chile, Department of Industrial Engineering.

Froot, K. and A.F. Perold. 1990. "New Trading practices and Short-Run Market Efficiency." Working paper 3498. Cambridge, Mass.: National Bureau of Economic Research.

Goldstein, M. and P. Turner. 2004. "Controlling Currency Mismatches in Emerging Markets." Washington: Institute for International Economics.

Hau, H. 2002. "Real Exchange Rate Volatility and Economic Openness: Theory and Evidence." *Journal of Money, Credit, and Banking* 34(3): 611–30.

Hodrick, R.J. and E. Prescott. 1980. "Postwar U.S. Business Cycles: An Empirical Investigation." Discussion paper 451. Carnegie-Mellon University.

International Monetary Fund. 2003. *Balance-of-Payments Statistics Yearbook 2003*. Washington.

————. Various issues. *International Financial Statistics*. Washington.

Jadresic, E., S. Lehmann, A. Rojas, J. Selaive and A. Naudón. 2003. "Balance financiero externo." Economic policy paper 7. Santiago: Central Bank of Chile.

Jeanneau, S. and M. Micu. 2003. "Volatility and Derivatives Turnover: A Tenuous Relationship." *BIS Quarterly Review* (March): 57–65.

Karpoff, J.M. 1987. "The Relation between Price Changes and Trading Volume: A Survey." *Journal of Financial and Quantitative Analysis* 22(1): 109–26.

Klitgaard, T. and L. Weir. 2004. "Exchange Rate Changes and Net Positions of Speculators in the Futures Market." *Economic Policy Review* (May): 17–28. Federal Reserve Bank of New York.

Kyle, A.S. 1985. "Continuous Auctions and Insider Trading." *Econometrica* 53(6): 1315–35.

Lee, B.-S. and O. Rui. 2002. "The Dynamic Relationship between Stock Returns and Trading Volume: Domestic and Cross-Country Evidence." *Journal of Banking & Finance* 26(1): 51–78.

Lyons, R.K. 2001. *The Microstructure Approach to Exchange Rates*. MIT Press.

Mark, N. 1995. "Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability." *American Economic Review* 85(1): 201–18.

Meese, R. and K. Rogoff. 1983. "Empirical Exchange Rate Models of the Seventies: Do They Fit out of Sample?" *Journal of International Economics* 14(1–2): 3–24.

Morandé, F. and M. Tapia. 2002. "Exchange Rate Policy in Chile: From the Band to Floating and Beyond." Working paper 152. Santiago: Central Bank of Chile.

Neely, C. and L. Sarno. 2002. "How Well Do Monetary Fundamental Forecast Exchange Rates?" Working paper 2002-007. Federal Reserve Bank of St. Louis.

Ross, S.A. 1989. "Information and Volatility: The No-Arbitrage Martingale Approach to Timing and Resolution Irrelevance." *Journal of Finance* 44(1): 1–17

Stein, J.C. 1987. "Informational Externalities and Welfare-Reducing Speculation." *Journal of Political Economy* 95(6): 1123–45.

Velasco, A. and P. Arellano. 2003. "Internacionalizar el peso: justificaciones, lecciones internacionales y tareas pendientes." Santiago: Ministry of Finance of Chile. Mimeographed.

Wei, S.-J. and J. Kim. 1997. "The Big Players in the Foreign Exchange Market: Do They Trade on Information Noise?" Working paper 6256. Cambridge, Mass.: National Bureau of Economic Research.

Yu, S.-W. 2001. "Index Futures Trading and Spot Price Volatility." *Applied Economic Letters* 8(3): 183–86.