Response to External and Inflation Shocks in a Small Open Economy

Vittorio Corbo
Central Bank of Chile

José Tessada
Massachusetts Institute of Technology

Monetary policy design has experienced major changes over the last twenty years. These changes had their origin in changes in macroeconomic theory, a better understanding of the importance of achieving and maintaining low inflation, and the abandonment of fixed pegs in favor of floating exchange rate regimes. The new macroeconomic models emphasize the role of microeconomic foundations and expectations and highlight the need to develop and strengthen institutions. One of the key consequences of this process is the recognition that stabilization policies cannot achieve permanent gains in output or employment.

The emphasis on credibility and the incorporation of explicit forward-looking expectations have similarly contributed to the recognition that monetary policy must have a forward-looking design. Given the lags between policy decisions and their effect on the real economy, it is necessary to contemplate not only the current values of relevant variables, but also forecast values in the right horizon. The need to generate forecasts of economic variables has led the institutions in charge of monetary policy to develop macroeconomic models

We benefited from comments and suggestions from Rómulo Chumacero, Klaus Schmidt-Hebbel, Francesco Giavazzi, Huberth Escaith, and José De Gregorio. We also thank Cecilia Peña and Matías Tapia, who generously provided us with data. The first version of the paper was written while both authors were affiliated with the Pontificia Universidad Católica de Chile. This version was completed while José Tessada was visiting the Research Department of the Central Bank of Chile. The views expressed are those of the authors and not necessarily those of the Central Bank of Chile.

General Equilibrium Models for the Chilean Economy, edited by Rómulo Chumacero and Klaus Schmidt-Hebbel, Santiago, Chile.

appropriate for forecasting the relevant variables that condition the monetary policy design. The available options are very wide, ranging from simple one-equation models of the most relevant variables to elaborate and microeconomic-founded models featuring rational expectations and a large number of estimated or calibrated relations that incorporate uncertainty in the solution, generating not only a point forecast but also a range for the key endogenous variables with a probability distribution.[1] Another important use of these models is the evaluation of the impact of different economic policy options; the clearest example is the analysis of the future evolution of inflation when central banks are deciding whether to change the interest rate or whatever variable they use as instrument.

Within this wide range, semistructural and small models have found an increasing role in macroeconomic analysis and policy design. These models incorporate reduced-form equations that can be obtained from the explicit solution of microeconomic-founded models. Although these models are not immune to the Lucas critique, they are robust enough to deal with monetary policy changes and related shocks. The use of small models reduces the level of detail, but such models have important advantages in terms of relatively easy and fast solution and intuition. Many small models are currently available, some of which have evolved from traditional models by incorporating new theoretical and empirical features.[2]

In this paper we present a small macroeconomic model for the Chilean economy. We start by explaining its structure and then present simulations of the dynamic response of the economy to some shocks that are of particular interest for Chile. The paper is organized as follows. The first section discusses macroeconomic models and monetary policy analysis in general, together with a brief review of recent macroeconomic models of the Chilean economy. The second section describes the model used in the rest of the paper, a model that is based on the traditional small open economy or dependent economy model. The third section analyzes the simulations and its results. The final section presents our main conclusions.

1. Good examples include the models used to elaborate monetary policy reports by most central banks that operate under an inflation-targeting framework. See, for example, the Central Bank of Chile's Monetary Policy Reports (available at www.bcentral.cl) and Bank of England (1999) for a description of the wide range of models they use.

2. In Taylor (1999), several models of this type are used to analyze issues related to monetary policy reaction functions. Walsh (2003) also reviews some of these models.

1. Macroeconomic Models for Monetary Policy Analysis in Chile

To provide a simple organizing framework for thinking about macroeconomic models, we briefly summarize the current state of macroeconomic models and some recent applications for Chile. Most of the recent work on macroeconomic models has been generated under what is called the new Keynesian synthesis, an important research effort to provide an updated and consistent framework for economic analysis that incorporates the macroeconomic developments of the last fifteen years.[3]

1.1 Macroeconomic Models and Monetary Policy: A Brief Explanation

Modern macroeconomic models for monetary policy analysis build on the tradition of the IS-LM-AS models, but with several important modifications that incorporate recent theoretical advances and important changes in the way economic policy is implemented.[4] The models are quite heterogeneous, however. Not all are clearly derived from explicit microeconomic foundations, and they do not necessarily incorporate rational expectations or impose all the cross-equation restrictions that are obtained from first-order conditions of optimizing decisions. Which model is most appropriate depends on the question the analyst is interested in exploring.

Macroeconomic models for studying the effects of policies and shocks on the trajectory of key macroeconomic variables are usually of three varieties: large-scale structural macroeconomic models; small models consistent with macroeconomic theory and forward-looking expectations; and small nonstructural models based on vector autoregressions (VAR).[5] Models in the first class are usually derived from first principles and incorporate a lot of detail, including explicit budget constraints and first-order conditions; rational expectations

3. Good examples of this orientation can be found in Kerr and King (1996), Clarida, Galí, and Gertler (1999), McCallum and Nelson (1999), and McCallum (2001).

4. The increasingly common use of interest rates as an instrument of monetary policy has led some researchers to change the traditional IS-LM specification for a new specification that Romer (2000) calls an IS-MP model.

5. Another important differentiation would be the explicit inclusion of uncertainty, but our main focus here is on the size and foundations of the models.

are used in simulations. One of the main advantages of these models is that because they are derived from first principles, all the parameter restrictions are imposed, expectations are derived consistently within the model, and the results are robust to the Lucas critique. The parameters in structural models have to be invariant to policy changes, and the models must therefore be derived from microeconomic foundations and have forward-looking expectations (McCallum, 2001). The main disadvantage of this type of model is the poor tracking of short-run dynamics.[6] An important example of this class is the real business cycle (RBC) model. RBC models are not designed to track the short-run evolution of the economy, but they have been applied to match correlations and other regularities of Chilean business cycles. As in most developing countries, however, the use of RBC models has been limited, and only recently has research increased in this area.

Another type of large-scale structural model that has been important in research is not derived from first principles, but is built using several empirical relationships that incorporate ad hoc specifications. These models closely track the movements in some macroeconomic aggregates. While most of the modifications are not explicitly founded on microeconomics, the models do describe a large number of variables that are then used to compute aggregate variables. Their main advantage is the possibility of incorporating a lot of detail about the interaction of several sectors and variables without loosing the ability to track the evolution of the aggregate variables. They are very useful for policy purposes, but their size is a disadvantage when the analyst needs quick answers to specific questions or when simple answers are sufficient.

The second type of model—namely, small models consistent with macroeconomic theory and forward-looking expectations—has proved to be very useful for monetary policy analysis. These models capture the main elements of an economy yet are simple enough to allow researchers and policymakers to answer simple questions without having to deal with an excessively detailed specification. Some of the models have been derived from simple first-order conditions of optimization problems faced by firms and consumers, but in general no cross-equation restrictions are imposed on the parameter for

6. See King (2000) and Woodford (2003) for reviews of the core structure of this type of model. Lane (2001) reviews the basic structure of the new open economy macroeconomic models; a seminal contribution in this area is Obstfeld and Rogoff (1995).

estimation purposes. Calibrated models can be easily constructed, however, so as to reflect results for different choices of deep behavioral parameters.[7] The models, which are usually interpreted as the result of dynamic neo-Keynesian models, incorporate rational expectations and generally also emphasize the explicit role of (the expected values of) forward-looking variables. Clarida, Galí, and Gertler (1999) analyze monetary policy using a simple model of this type as their framework; this widely cited work shows the basis of the research in this area.

The basic structure of these models generally comprises a single-equation description of aggregate demand (an open economy IS equation), a pricing or aggregate supply equation (originally an expectations-augmented Phillips curve), and an equation or a block describing monetary policy decisions. The choice of an IS equation for describing aggregate demand generally is not questioned, and while specific issues regarding timing and the inclusion of forward-looking variables have important theoretical considerations, empirical works tend to choose according to goodness of fit more than strict theoretical underpinnings. Regarding the monetary policy specification, these models, like most research on monetary policy since Taylor (1993), usually include a Taylor reaction function describing the behavior of monetary authorities.[8]

The most important and controversial element is the pricing or aggregate supply equation. Economists do not question the characteristics of the long-run supply curve, but issues involving the short-run specification are not clear. The first problem relates to the long-standing debate between neoclassical and neo-Keynesian specifications, which we do not expect to solve here.[9] The second important issue arises from the empirical fact that the inflation rate exhibits significant inertia, whereas traditional models derive only price-level inertia and not inflation inertia. This is not a minor issue in that inflation inertia is closely related to the idea that disinflation processes are costly in terms of output and employment. Different approaches have been tried, yet there is no consensus on a clear theoretical solution. Fuhrer and Moore (1995) present an early

7. Walsh (2003) presents some of the models in this class that are currently in use.

8. One of the main uses of these simple models is to analyze robustness of different policy rule specifications under different parameterizations of the model.

9. Recent reviews of these models can be found in Rosende (2000), Woodford (2003), and Walsh (2003).

approach, and Mankiw and Reis (2002) develop an interesting approach related to early work by Fischer (1977).

The third type of model—that is, the small nonstructural VAR models—is increasingly used to analyze the effects on key endogenous variables (such as output, inflation, and unemployment) of unexpected or unsystematic shocks to policy or exogenous variables. The popularity of these models increased after Sims (1980) critiqued the ad hoc specifications of the models then in use. Their main characteristic is the absolute lack of predetermined structure. All the relations are derived from the time series specification, which can be used to derive simple and very intuitive results such as impulse responses and variance decomposition figures.[10] The models' simplicity explains both their advantages and disadvantages. When used wisely, VAR models can provide very useful insights into dynamic properties and a simple description of comovements between different economic series.

1.2 A Brief Survey for Chile

The literature on economic policy and economic performance has become one of the most active in Chile over the last fifteen years. The fact that Chile was an early reformer led most think tanks and similar institutions to study the country to develop a general framework for guiding reform efforts in other developing countries. Questions about the role played by monetary, exchange, and fiscal policy in the rapid recovery and stabilization of the country after the severe crises of the 1970s and 1980s were initially at the center of the macroeconomic research. Several new issues have since come to the forefront of economic research, but the one that interest us is monetary policy analysis. As early as 1991, Chile adopted an inflation-targeting framework for the implementation of monetary policy. Initially understood as a simple forecast, the projection soon became a target for monetary policy; it was not the only objective, but it was the most important one.[11] New questions emerged following the abandonment

10. For a review of this methodology, see Stock and Watson (2001) and Hamilton (1994).

11. For a review of monetary policy and the Chilean economy in the late 1970s and 1980s see Corbo and Fischer (1994). Reviews of monetary policy in the 1990s can be found in Massad (1998), Corbo (1998), Morandé (2001), Corbo and Tessada (2002), and Schmidt-Hebbel and Tapia (2002). More comprehensive reviews of the Chilean economy can be found in Bosworth, Dornbusch, and Labán (1994) and Larraín and Vergara (2000).

of the exchange rate band after the Russian and Brazilian crises and the achievement of a low inflation level in 1999. The increasing integration in international financial markets and the already high dependency on the evolution of commodity markets make the country very vulnerable to external shocks. The need to assess the effect of these shocks and other issues related to the design of monetary policy has motivated researchers and policymakers to construct useful models for economic policy analysis. The available literature on the topic is growing very fast, which precludes compiling an exhaustive survey in a brief section. We thus review six papers: Bergoeing and others (2002), García and others (in this volume), Corbo and Schmidt-Hebbel (2001), Corbo and Tessada (2002), Valdés (1998), Cabrera and Lagos (2002), and Mies, Morandé, and Tapia (2002).[12]

Bergoeing and others (2002) present a calibrated growth model, which is used to explain differences between Chile and Mexico after the debt crisis. They use the model to account for possible alternative explanations and to explore the role played by static and dynamic inefficiencies in the evolution of both economies. They find evidence supporting their hypothesis that reforms are at the center of the differences. Instead of the traditional reforms claimed by most authors, however, they identify banking and bankruptcy laws as key elements explaining the different patterns.

García and others (in this volume) construct a large-scale model for monetary policy analysis at the Central Bank of Chile. Using calibrated and estimated equations, the model is built in blocks, each of which describes a different sector of the economy. The blocks are then aggregated and used to model different monetary policy transmission channels. Not all the equations are derived from first principles, and almost no cross-equation restrictions are placed on the parameters. The two main features of the model are a very detailed external sector, justified by its great influence on the evolution of the Chilean economy, and a production block built according to a Cobb-Douglas production function, which captures the stable factor shares observed during the period under analysis. The model is simulated to compute the dynamic response of the economy to several transitory

12. Duncan (in this volume) presents a detailed review of RBC models calibrated for the Chilean economy since 1990. Cabrera and Lagos (2002), Mies, Morandé, and Tapia (2002), and Chumacero (in this volume) discuss papers that use a VAR methodology. Gallego, Servén, and Schmidt-Hebbel (in this volume) describe large-scale dynamic macroeconomic models derived from first principles; a mixture of estimated and calibrated formulas is used for simulation.

and permanent shocks. When possible, the responses are contrasted with those obtained from a simpler model and a VAR model. The results are relatively similar, but the model accounts for the responses with greater detail and supports the analysis of shocks that might affect the steady-state values, a feature that is not present in any of the other models presented by the authors.

Corbo and Schmidt-Hebbel (2001) and Corbo and Tessada (2002) present similar models to answer different questions. The model is a reduced version of the Salter-Swan-Dornbusch small open economy model, and it tests and imposes homogeneity in nominal variables in the price and wage equations to ensure a vertical long-run Phillips curve. Corbo and Schmidt-Hebbel (2001) simulate the model under counterfactual scenarios to try to shed some light on the role of credibility and the inflation target in the sustained reduction of inflation experienced by Chile in the 1990s. The authors find that the introduction of the target helped anchor expectations and that the gradual approach allowed the authorities to reduce inflation without the large cost associated with a cold-turkey approach. They do not explicitly model the steady state, so they cannot answer questions related to shocks or policy changes that might affect the real equilibrium of the economy in the long run. In fact, the underlying assumption in the analysis is that any change in the inflationary regime or the monetary policy framework does not cause a significant change to the long-run output level.

Corbo and Tessada (2002) use a very similar model with some slight modifications, together with a nonstructural VAR, to assess the importance of different factors that might account for the 1998–1999 slowdown of the Chilean economy. The nonstructural VAR is used to forecast the effects of different shocks on the trajectory of the main macroeconomic aggregates. The more structured model is then simulated to generate counterfactual scenarios for the crisis periods to inspect the role played by different factors, including the monetary policy response, in the subsequent slowdown of activity in the Chilean economy. Their main conclusion is that part of the monetary policy response can be justified as an attempt to defend the inflation target for the following year. Part of the slowdown, however, can be blamed on a severe anti-inflationary attitude on the part of the Central Bank, even after taking into consideration the external factors.

Valdés (1998) estimates a semistructural VAR model in which he makes assumptions that allow him to identify the monetary policy shocks without adding more structure to the VAR, so that the rest of the shocks are not studied in the paper. After reviewing the previous literature on VAR models, the author presents his own results based on a modification relative to previous work: he argues that monetary policy affects the gap between the inflation rate and the target, rather than the inflation rate itself. When using the modified specification, he finds that monetary policy has significant effects on both the inflation gap and the monthly activity index (Imacec).[13]

Cabrera and Lagos (2002) use structural VAR models to compare alternative hypotheses about monetary policy transmission mechanisms. The analysis is carried out by estimating a different VAR model for each of the competing hypotheses. The authors conclude that there is weak evidence of a price puzzle result in Chile, and that spending and output do not respond significantly to the interest rate. Instead, they show significant responses to nominal money supply. They interpret this as raising doubts on the selection of the monetary policy instrument. However, the results presented in the paper are not robust to different structural identifying assumptions or to changes in the specification of the VAR model. Moreover, the results range from finding negative and significant effects of monetary policy on inflation to finding evidence of a possible price puzzle.

Finally, Mies, Morandé, and Tapia (2002) employ single-equation and VAR models to analyze the effectiveness of monetary policy in the 1990s. The single-equation analysis estimates an equation relating the twelve-month rate of change of a monthly activity index as a function of its own lag and a lagged measure of a monetary policy shock, where the latter variable is identified as the residual from the estimation of a monetary policy function. They find evidence of a change in the effectiveness of monetary policy, identified as the coefficient of the monetary shock in the regression. When they look at the nonsystematic part of monetary policy, however, the systematic portion of monetary policy movements is left out of the analysis, so they cannot address its effect.[14] They then move to the analysis

13. A counterintuitive aspect of his approach is that he uses forecasts published by a private forecaster to extend the data on the target for the 1980s, which by their own nature cannot be considered to play the same role as the inflation target in the economy. Corbo and Schmidt-Hebbel (2001) follow a different approach: they show that when the inflation target is included in a nonstructural VAR model, the dynamic forecasts are closer to the forecasts published by Consensus Forecasts for the corresponding periods; they interpret this as evidence of the target as an anchor for inflation expectations.

14. See Bernanke, Gertler, and Watson (1997) on the importance of the systematic component of monetary policy in the case of the United States.

using VAR models, estimating different specifications with different samples and finding significant differences in the estimated monetary policy elasticities of inflation and output. The major innovation of the paper is the use of different monthly sectoral indicators. They estimate VAR models to study the effect of monetary policy on different economic sectors, showing that the construction and manufacturing sectors are the most affected by the monetary policy shocks, with the construction sector experiencing an effect that is about twice as large as for the aggregate economy.

2. The Model

As explained above, a variety of models have been used to analyze different questions about the Chilean economy since the 1980s.[15] Our model is related to most of the literature dealing with macroeconomic analysis of the country, in particular several papers that address issues associated with monetary, exchange rate, and disinflation policies since the early experiments of the late 1970s. Many papers issued over the last five years explore monetary policy considerations under an inflation-targeting framework. Most of these present small empirical models based on ad hoc specifications in order to capture empirical regularities observed in the Chilean economy. Their theoretical underpinnings lie in the traditional small open economy models of Salter, Swan, Dornbusch, and Corden, but they expand their models to incorporate new elements based on recent empirical and theoretical developments. Examples of this model include Edwards (1993), Corbo (1985), Corbo and Fisher (1994), Corbo and Schmidt-Hebbel (2001), and Corbo and Tessada (2002).

Our interest in building this model is to capture the relevant macroeconomic features of the economy for short- and medium-run analysis of the effects of exogenous shocks, including the endogenous response of monetary policy. García and others (in this volume) identify seven stylized facts about the Chilean economy, of which we directly model two: the sensitivity of the domestic cycle to external conditions and the combination of inflation rate, inflation targets, and economic cycle. The other five are not explicitly modeled because of our focus on the short run and our assumption that the long-run equilibrium is

15. The papers presented in this volume are a good example of the diversity of the research during the recent years.

exogenous to our model.[16] We hold that these two facts are the main elements for short-run analysis. Most of the other characteristics, as important as they are, will not change the general properties of the model; the gain in detail would be at the cost of a larger, more complicated model.[17]

The model's main equations consist of an IS equation explaining the evolution of the domestic output gap, a transition equation linking the evolution of real exchange rate deviations to other exogenous and endogenous variables, an inflation equation that can be related to the Fuhrer and Moore (1995) specification of a pricing equation in the United States, and a Taylor rule describing monetary policy. We estimated each equation separately to avoid spillover effects from specification errors in a particular equation to the estimation of other equations in the model.

The first equation in the model is a simple version of an open economy IS equation relating the domestic output gap (y) to internal and external demand factors.[18] External factors play an important role: the coefficients for the output gap of the main trade partners (y^*, henceforth, the foreign output gap), the real exchange rate (*RER*), and capital inflows (*CAPFLOWS*) are statistically significant, and the impact effects are of a relevant magnitude. Since capital inflows could be endogenous to the output gap, we use a measure of the availability of flows to the Chilean economy instead of capital inflows. This measure is constructed by adding up the supply of external funds from the euro area, Japan, and the United States and then dividing the sum by the total output of the three regions, a measure that can be considered exogenous. The importance of capital flows in the evolution of the domestic output gap can be linked to the "sudden stop" hypothesis—in particular, with Caballero's argument that the connection between developing countries and capital flows is through quantities more than through interest rates (Caballero, 2002). This evidence does not represent a careful analysis of the hypothesis, but it sheds some light on the

16. This assumption may seem overly heroic, but it is very useful when analyzing responses to transitory shocks. It does, however, restrict the size of the transitory shocks, because in some general equilibrium models for small open economy models, the evolution of the net foreign assets might lead to permanent effects of transitory shocks (see Lane, 2001).

17. García and others (in this volume) contrast their results with results derived from a VAR model and a smaller structural model.

18. Potential output was computed according to the methodology presented in Contreras and García (2002).

problem.[19] We are not estimating a neo-Keynesian version of the IS equation because the expected future level is not included as an explanatory variable, a condition that is derived from intertemporal optimization.

The only internal variable considered in the specification is the real monetary policy rate (*RMPR*), expressed as a deviation from an equilibrium value that is not restricted to being constant over time.[20] This value also corresponds to the steady-state equilibrium of the monetary policy rate, so it can be interpreted as the natural interest rate. We do not differentiate between short and long interest rates; this simplification allows us to keep the model very simple at the cost of detail on the effect of short rates on long rates and on real activity. We also estimated an alternative specification in which we included the terms of trade as an additional explanatory variable (instead of the real exchange rate), but this did not generate significant changes in the results. Equation (1) shows the estimated open economy IS equation for the Chilean economy:

$$y_t = \underset{(0.114)}{-0.002} + \underset{(0.256)}{0.512} y^*_{t-2} + \underset{(0.036)}{0.079} RER_{t-3} + \underset{(0.259)}{1.151} CAPFLOWS_{t-1} - \underset{(0.086)}{0.276} RMPR_{t-2} + \underset{(0.057)}{0.737} y_{t-1}, \qquad (1)$$

where the estimation method is ordinary least squares (OLS); Newey-West robust standard errors are reported in parenthesis; R squared equals 0.91; the LM test (1) is 0.276 (with a p value of 0.601); and the sample runs from the first quarter of 1987 through the fourth quarter of 2002.

The next equation in the model corresponds to the monetary policy reaction function. The dependent variable (*RMPR*) is expressed as a deviation from an equilibrium value, which also corresponds to the steady-state equilibrium of the interest rate in the model. As explained above, this value is not assumed to be constant over time.[21]

Estimating an equation like equation (2), as explained in Clarida, Galí, and Gertler (1998) and Corbo (2002), is complicated because two right-hand-side variables depend on the observed values of the interest

19. This is an interesting topic that needs more attention from an empirical point of view.

20. Calderón and Gallego (2002) discuss the natural interest rate for the case of Chile.

21. The equilibrium value was calculated by computing moving averages of the observed policy interest rate or by applying a Hodrick-Prescott (HP) filter to the original series. The results are not very sensitive to the procedure used. The version of equation (2) presented in the paper corresponds to the deviation computed using the HP filter.

rate. Following previous work on the issue, we use generalized method of moments (GMM) to solve the problem.[22] We introduced a change in our definition of the policy rate used by the Central Bank of Chile. Here, following Valdés (1998), instead of using the real rate of the ninety-day Central Bank adjustable bills (the PRBC-90), we use a hybrid variable called policy rate, which consists of the PRBC-90 up to April 1995 and thereafter the monetary policy rate (*tasa de instancia*). However, as shown in Corbo and Tessada (2002), this rate was not a clear indicator of the true monetary policy stance in several specific months in 1998.[23] We therefore replaced these values with the PRBC-90 rate and then proceeded to compute the quarterly averages. For the period when the monetary policy rate was announced as a nominal rate, we subtracted the inflation target to get the implicit real rate.

Some previous papers on the topic estimate the policy function for the 1990s with the current account as an alternative target for the Central Bank, as was explicitly recognized by the authorities at the time.[24] The orientation of monetary policy changed after 1998, however, so we modified the specification by including the output gap (y) as the other variable. The results are relatively satisfactory, but it is too soon to derive hard conclusions about the new structure of the policy function.[25]

$$RMPR_t = \underset{(0.102)}{0.539}\left(\pi - TAR\right)_{t+3} + \underset{(0.019)}{0.067}y_t - \underset{(0.059)}{0.561}RMPR_{t-1}\,, \tag{2}$$

where π is inflation and TAR is the inflation target; the estimation method is generalized method of moments (GMM); the weighting matrix is robust to heteroskedasticity and autocorrelation; robust standard errors are shown in parenthesis; and the instruments are lags of the right-hand-side variables and of external inflation. R squared equals 0.855, and the sample runs from the first quarter of 1995 through the first quarter of 2002.

22. For a review of generalized method of moments, see Hamilton (1994), Greene (2002), and Mátyás (1998). For a review of previous works on estimating monetary policy reaction functions, see Clarida, Galí, and Gertler (1998) in the case of developed countries and Corbo (2002) in the case of Latin American countries.

23. The months with this problem are January, August, September, October, and November of 1998.

24. See Massad (1998). See also Corbo (2002) and Corbo and Tessada (2002) for previous estimations of monetary policy reaction functions for the 1990s.

25. The model was estimated using only the inflation gap as an explanatory variable. It must be emphasized that obtaining a statistically significant coefficient for the output gap in the right-hand side of the equation does not imply this variable is another objective for the Central Bank.

The model includes core inflation as the relevant measure of inflation. In our specification, we identify four different variables affecting the dynamics of core inflation, π: external inflation (reflected in the real exchange rate misalignment, *RER*), internal inflationary pressures (summarized in the output gap, y), forward looking expectations (incorporated through market expectations or through leads of core inflation), and persistence in the inflation rate (owing to indexation or measurement).[26] Growing evidence indicates that exchange rate pass-through is not constant over the cycle and likely depends on more variables. We do not, however, explore major deviations from our simple linear specification here because our initial explorations did not identify any interaction or nonlinearity in the specification that could be associated with a nonconstant pass-through.[27] Other authors find such effects in the Chilean economy under different specifications and with different purposes (see García and Restrepo, 2001; Schmidt-Hebbel and Tapia, 2002).

We modeled the forward-looking component of the inflation equation in two different ways. Our first version incorporates as a forward-looking variable the expected inflation computed from the difference between nominal and indexed interest rates of the same maturity (90 to 360 days). This variable is intended to measure market expectations without further restrictions about model consistency, and it is modeled in a way that simply reflects a slow adjustment of expectations.[28] The second version assumes rational expectations, and we use the effective future inflation rate (with the corresponding leads matching the timing of the previous version) as a proxy for expected inflation. Under rational expectations, we can use GMM and estimate the equation using as instruments known variables that are useful for forecasting purposes. This specification includes model-consistent expectations. We incorporated two lags of inflation, which

26. Our dependent variable is the four-quarter rate of change of the core price index (the IPCX in the Central Bank's nomenclature).

27. Taylor (2000) explains how to rationalize a correlation between lower inflation variability and lower exchange rate pass-through. Choudhri and Hakura (2001) test the implications derived by Taylor (2000) for a comprehensive set of countries for the period 1979–2000. They confirm the existence of a positive relation between the pass-through and the average inflation level, which is related to Taylor's idea about permanent and transitory effects (see Taylor, 2000). Goldfajn and Werlang (2000) present a comprehensive study analyzing possible determinants of the magnitude of the pass-through.

28. This variable is explained using a simple equation that relates it to leads of the inflation target and lagged core inflation.

were selected to avoid autocorrelation of the residuals. The first version of the equation is the following:

$$\pi_t = \underset{(0.031)}{0.068} RER_{t-1} + \underset{(0.040)}{0.096} y_{t-1} + \underset{(0.083)}{0.175} E^{M}_{t-1}(\pi_{t+1}) + \underset{(0.207)}{1.117} \pi_{t-1} - \underset{(—)}{0.292} \pi_{t-2} \quad (3)$$

where the estimation method is OLS; Newey-West robust standard errors are reported in parenthesis; *R* squared equals 0.96; the LM test (1) is 2.13 (with a *p* value of 0.15); and the sample runs from the first quarter of 1991 through the fourth quarter of 2002. The second version, with rational expectations, is specified as follows:

$$\pi_t = \underset{(0.032)}{0.058} RER_{t-1} + \underset{(0.028)}{0.044} y_{t-1} + \underset{(0.035)}{0.210} \pi_{t+1} + \underset{(0.183)}{1.061} \pi_{t-1} - \underset{(—)}{0.271} \pi_{t-2} \ , \quad (3')$$

where the estimation method is two-stage least squares (2SLS); Newey-West robust standard errors are reported in parenthesis; and the instruments are lags of the right-hand-side variables, lags of core inflation, lags of the inflation target, and lags of external inflation. *R* squared equals 0.98, the LM test (1) is 2.23 (with a *p* value of 0.14), and the sample runs from the first quarter of 1991 through the first quarter of 2002.

The only puzzling element is that replacing the market expectation with the observed rate causes a significant change in the value of the parameter that measures the effect of the cycle. The change cannot be blamed on an endogeneity problem because the parameter value does not significantly differ when equation (3') is estimated using 2SLS versus OLS. One possible explanation might be a feedback from the right-hand-side variables into expectations or into leads of the inflation rate; an additional explanation might be a problem with the instruments in the 2SLS estimation. Despite the rational expectations alternative, the main version of the model used in the simulations incorporates equation (3) as the relevant pricing equation, complemented by a simple equation for inflation expectations.

We now turn to the main variable that connects the external sector with the evolution of domestic variables: the real exchange rate. The model defines the real exchange rate relative to Chile's main industrial trade partners, namely, Canada, the members of the euro area, Japan, the United Kingdom, and the United States. The real exchange rate is the main variable reflecting the evolution of the external sector; the selected specification includes the domestic output gap (y) and lagged values of the real exchange rate deviation (RER) as explanatory variables of the gap between the observed real exchange rate and a long-run value.[29] Alternative specifications include the difference between the domestic output gap and the foreign output gap, as well as the terms of trade (as the log deviation from a long-run value), but the results do not change significantly. A different approach is to impose interest rate parity and include additional variables, but the use of very detailed and specific capital controls—which changed in the 1990s—implies that the imposition of interest rate parity might be misleading unless the right effect of the capital controls is taken into account.[30]

$$RER_t = \underset{(0.113)}{0.639}RER_{t-1} - \underset{(0.148)}{0.403}RER_{t-2} + \underset{(0.097)}{0.418}RER_{t-3} - \underset{(0.105)}{0.229}y_t \ , \qquad (4)$$

where the estimation method is 2SLS; Newey-West robust standard errors are reported in parenthesis; and the instruments are lags of the right-hand-side variables, lags of the real exchange rate gap, and lags of the foreign output gap and capital flows. R squared equals 0.45, the LM test (1) is 0.82 (with a p value of 0.37), the LM test (4) is 1.18 (with a p value of 0.88), and the sample runs from the first quarter of 1986 through the fourth quarter of 2002.

The short-run specification of the real exchange rate must be interpreted carefully because we do not include any of the nominal variables that are known to be important when forecasting the real exchange rate in the short run.[31] As in most of the literature on macroeconomic models for Chile, the short-run evolution of the real exchange rate follows an ad hoc specification; our definition intends to capture movements of the real exchange rate that are associated with medium-run deviations and that do not necessarily follow short-run volatility from the exchange rate market.[32] This assumption is relevant for the interpretation of the simulations presented in the

29. This long-run value is also the steady-state equilibrium of the real exchange rate in this model.

30. Two recent reviews of the Chilean experience with capital controls are Gallego, Hernández, and Schmidt-Hebbel (2002) and De Gregorio, Edwards, and Valdés (2000).

31. Three recent papers on the topic for Chile are Gallego, Hernández, and Schmidt-Hebbel (2002), Calderón and Massad (2003), and Cerda, Donoso, and Lema (2003).

32. We here understand the medium run as a period long enough for real variables to be important for explaining real exchange rate fluctuations, but not necessarily as long as the half-life of purchasing power parity (PPP) shocks. For different approaches, see García and others (in this volume), García, Herrera, and Valdés (2002), Gallego, Servén, and Schmidt-Hebbel (in this volume), and Corbo and Tessada (2002).

next section. The focus on more permanent movements of the real exchange rate means that in our model, changes associated with short-run volatility will not generate a response in either the output gap or the inflation rate, and these short-run fluctuations are not even modeled in this paper. We thus assume that transitory deviations do not imply an acceleration of inflation, whereas in real situations the effect of an observed change is not clear until economic agents can identify whether it is transitory or volatile.

Blanchard (2004) postulates a different approach.[33] Under certain assumptions about imperfect capital mobility, he obtains an expanded parity condition that allows for a slightly different specification with respect to the traditional uncovered interest rate parity. He thereby explicitly incorporates the sovereign risk premium without imposing more conditions on the value of the equation's parameters.

The four equations presented above constitute the core block of the model. In addition, all the exogenous (external) variables can be modeled using autoregressive processes (possibly a multivariate autoregressive process) capturing any cyclical behavior in the different shocks. Any simulation can be implemented with or without these time series processes.

3. Simulation Exercises

This section uses the model just presented to explore the impact of external shocks on the Chilean economy. This has been an issue in the policy and academic economic debate in recent years. Although the external cycle is known to have a strong impact on domestic output, the dynamic effects have only recently been clearly characterized.[34] Another interesting area for analysis involves the dynamic response of the economy to internal shocks, especially inflation shocks resulting from changes in regulated prices or other exogenous changes. Our model presents a simple, easy-to-use alternative for this purpose to the extent that it captures most of the short-run issues in a very simple framework.[35]

33. Favero and Giavazzi (2003) use this equation to study the effects of non-Ricardian fiscal policies in Brazil.

34. The papers summarized in section 1 provide fairly good coverage of the current state of research on this topic.

35. García and Valdés (2003) build a very similar model to illustrate the interaction of money and inflation under the inflation-targeting framework currently in use in Chile. They do not present estimations of their model, however.

We analyze three different shocks to the Chilean economy: an inflation shock, a foreign output gap shock, and a capital inflow shock. These three shocks reflect most of the variables that are currently relevant for monetary policy in Chile. We compare the evolution of three variables for each shock: the inflation rate, the policy rate, and the domestic gap. In the particular case of the inflation rate shock, we analyze the evolution of these three variables under two different scenarios. The first is based on the model as presented in the previous section and incorporating equation (3) for the inflation rate; the second replaces equation (3) with a calibrated relation that changes the weights on the forward-looking and backward-looking elements, most notably changing the coefficient of expected inflation to 0.7 while lowering the coefficient of lagged inflation to 0.3.

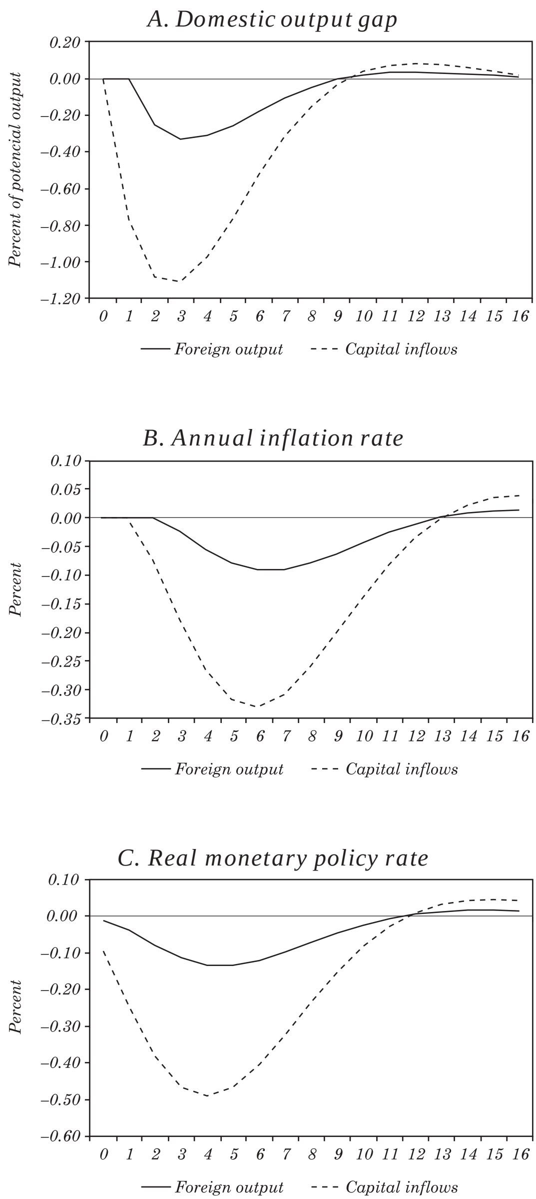
The structure of the simulation is as follows. We started by setting the initial values for all the endogenous and exogenous variables (and the market inflation expectations when used) equal to their 2001–2002 average values and then simulating the model forward using simple autoregressive processes for the exogenous variables; this simulation gives us the benchmark for comparing the effect of all the shocks.[36] We then ran the simulation again, this time incorporating the shocks in the model. In particular, the inflation rate shock is defined as a 0.5 percent higher inflation rate in the initial period. The shocks to the foreign output gap and the capital inflows are defined as a reduction equivalent to one standard deviation computed using the entire sample, which implies a shock equal to 0.5 percent for the foreign output gap and 0.67 percent for the capital inflows. All the shocks are defined as transitory, and we only report the effects when the shocks are allowed to show persistence or autocorrelation. The results are qualitatively similar, with significantly lower persistence if we do not incorporate the autoregressive specifications for the external variables in the model.[37]

We now turn to the description of our results. The effect of the external shocks resembles the traditional dynamic effects of an aggregate demand shock, lowering both the domestic output gap and the inflation rate (see figure 1). Monetary policy endogenously

36. A more traditional way to simulate the model is to assume that the model is in the steady state and then apply the shocks; given the structure of the model, the solutions do not differ significantly. Another alternative would be to calibrate some of the equations so as to set a particular period as the steady state and then compute the evolution of the model starting from this steady state; this is the approach followed by Gallego, Servén, and Schmidt-Hebbel (in this volume).

37. The results for these simulations are available on request from the authors. The specification used does not incorporate cross-correlation between the shocks; all the time series processes are assumed to be univariate.

Figure 1. External Shocks: Quarterly Deviation from the Base Scenario



Source: Authors' own calculations. See the text for details.

responds to both effects and shows a significant reduction. Comparatively, the effect of foreign output is of a reduced magnitude with respect to the capital flow shock, something that could be inferred by simple inspection of the coefficients in the IS equation. The propagation mechanism appears in the graphs with the external variables affecting first the output gap and then the inflation rate; monetary policy reacts to both effects by lowering the real rate in response to reduced domestic activity and taking advantage of the room created by the low inflationary pressures.

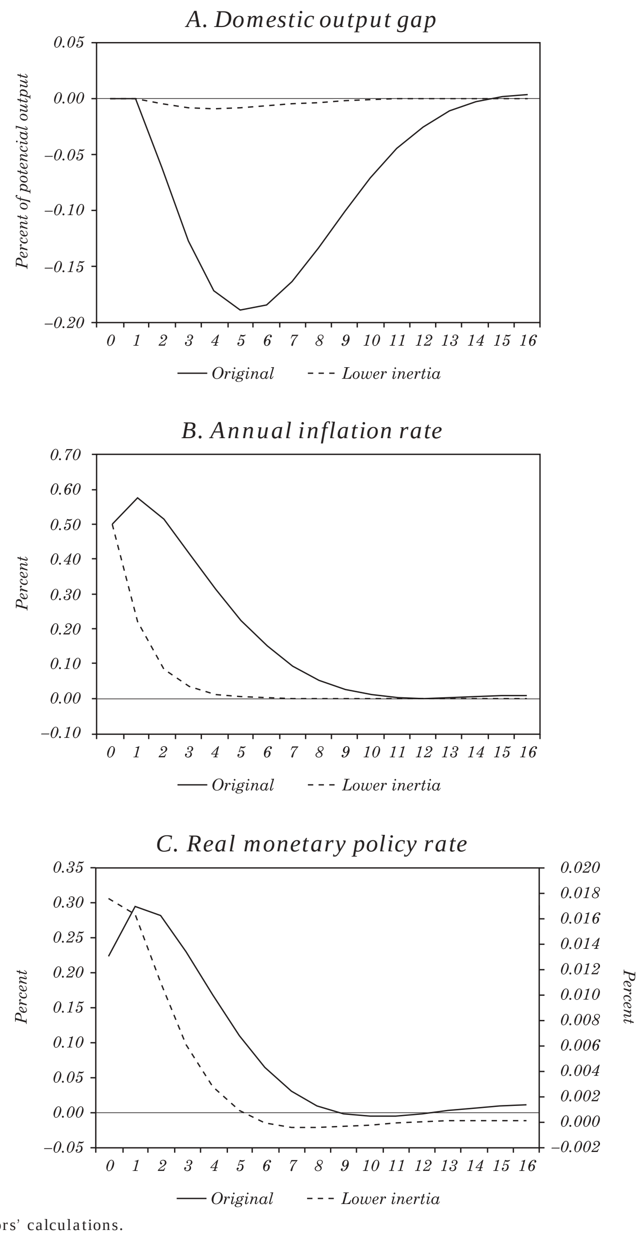
The effects are relatively important. Panel A of figure 1 illustrates that after three quarters the effect of the capital flow shock on the domestic output gap is 1.1 percent of potential output, while the maximum effect in the case of the foreign output gap is 0.32 percent (reached three quarters after the shock). For the inflation rate, the maximum effects are observed six quarters after the shocks, reflecting the propagation from output to inflation of these aggregate demand shocks (panel B).

Monetary policy turns out to be the most endogenous of all the variables under analysis. It initially responds to the reduction in the domestic output gap, but it is only when the inflation rate starts to fall that monetary policy effectively reacts with an aggressive reduction in the real rate, a result that probably generated a more precipitated recovery in domestic activity. The maximum reductions in the real interest rate are observed four to five quarters after the shock, but the response started to build immediately after the shock occurred, which emphasizes the forward-looking behavior of monetary policy (panel C).

All in all, the dynamic responses derived from the model confirm the important role that external factors play in the evolution of the Chilean macroeconomy. Even in a very simple model like the one presented in this paper, the results reflect a fact that is common knowledge among policymakers and other researchers in Chile.

Figure 2 depicts the simulation results for the case of the inflation rate shock. The series labeled *Original* corresponds to the solution when the 0.5 percent shock is simulated using equation (3). Panel B in the figure indicates that the inflation rate reaches its peak two quarters after the shock. The subsequent evolution reflects the important inflationary inertia found in the specification and also the parsimonious response of monetary policy to the shock. The effect disappears seven to nine quarters after the shock, but about half of the effect has already disappeared by the fourth or fifth quarter.

Figure 2. Inflation Rate Shock: Quarterly Deviation from the Base Scenario



Source: Authors' calculations.

Inflation expectations play a key role by anchoring the evolution of the observed inflation rate to the Central Bank's target rate, assumed to be 3 percent for the simulations.

Panel A of figure 2 shows that the domestic output gap suffers a significant slowdown after the inflation shock is observed, reaching its lowest value five quarters after the shock. This reduction in domestic activity must occur because of the increase in the interest rate, since there is no direct connection from the shock to aggregate demand. In fact, this effect on output vanishes if we simulate the same shock replacing equation (2) with a simple time series process that does not allow for an endogenous response of monetary policy to the inflation rate.[38]

As usual, monetary policy reflects the evolution of future inflation with a small influence from the possible output costs of any increase in the policy rate (see equation (2)). The dynamics are straightforward: monetary policy reacts in advance so as to slow the acceleration in the inflation rate through its effect on domestic output.[39]

To explore the relevance of inflation inertia in the dynamics of the economy, we construct a counterfactual exercise in which we replace equation (3) with a calibrated relation that changes the weights on the forward- and backward-looking (inertia) components of the inflation equation. The new weights are 0.7 for the expectation component and 0.3 for the lag of inflation. The simulation follows the same procedure as before, and the shock is of the same magnitude. The new results are shown in the corresponding panels of figure 2. The inflation rate shows exactly the same impact effect, but its persistence is significantly lower and is almost zero after two or three quarters. Of course, this difference implies significant differences for the rest of the variables. With the reduced endogenous persistence in inflation, monetary policy shows a very mild response that looks similar to the original simulations, but on a scale about 15 times smaller. In this case, a short-lived response of about a couple of basis points corresponds to the peak on the policy rate. The mapping into the output gap is obvious, with a very low inflation inertia, and the small

38. This comes from the implicit structure of the markup assumed in the pricing equation estimated in the model. This result is no longer valid if we allow for cost pressures on the production decision.

39. Given that we could not find an interest rate effect on the real exchange rate and that we did not impose interest rate parity in the exchange rate equation, we are ignoring a more immediate channel from monetary policy to inflation through an exchange rate pass-through.

reaction by the monetary authorities means that the domestic output gap shows almost no effect. Hence, the results are as expected, meaning that inertia increases the output cost of any anti-inflationary policy. Additional simulations show that the results are qualitatively the same if the model is simulated using equation (3') instead of our base specification with market expectations, such that our results are not a particular feature of our specification for the inflation equation.

4. Conclusions

We have built a small macroeconomic model of the Chilean economy to analyze the dependence of the evolution of economic activity on the external environment. Two main findings emerge from the simulation results. First, the counterfactual exercises confirm the Chilean economy's strong dependence on the external environment. Each shock analyzed generates nonnegligible effects on the economy. Relatively modest reductions in capital inflows and external activity can generate relatively significant effects in the output level, with the effect of capital inflows seeming to be particularly important. This dependence is to be expected given the high degree of openness of the Chilean economy, in that international trade and external financing are important relative to the size of the economy.

Second, with regard to the role of monetary policy in the adjustment to the shocks, we find that forward-looking behavior and a high credibility of monetary policy allows the authorities to deal with important shocks that can have significant transitory effects. In fact, simulations of the effects of an inflation shock highlight the importance of both forward-looking behavior and credibility on the inflation target, as the target anchors market expectations and thus affects the path of inflation and the rest of the variables. The degree of inertia in the inflation process is also a source of rigidities, however. The simulations show that it generates important variation in the side effects of the shocks, particularly in the cost of inflation stabilization after an inflation rate shock. This result is standard in the type of models analyzed in our paper.

Possible areas for further research include an empirical study of the effects of capital inflows on aggregate demand, together with an analysis of the change in monetary policy after nominalization and the abandonment of the exchange rate band.

References

Bank of England. 1999. *Economic Models at the Bank of England*. London.

Bergoeing, R., P. Kehoe, T. Kehoe, and R. Soto. 2002. “A Decade Lost and Found: Mexico and Chile in the 1980s.” *Review of Economic Dynamics* 5(1): 166–205.

Bernanke, B., M. Gertler, and M. Watson. 1997. “Systematic Monetary Policy and the Effects of Oil Price Shocks.” *Brookings Papers on Economic Activity* 1997(1): 91–157.

Blanchard, O. 2004. “Fiscal Dominance and Inflation Targeting: Lessons from Brazil.” Massachusetts Institute of Technology. Mimeographed.

Bosworth, B., R. Dornbusch, and R. Labán. 1994. *The Chilean Economy: Policy Lessons and Challenges*. Washington: Brookings Institution.

Caballero, R. 2002. “Coping with Chile’s External Vulnerability: a Financial Problem.” In *The Challenges of Economic Growth*, edited by N. Loayza and R. Soto. Santiago: Central Bank of Chile.

Cabrera, A. and L. Lagos. 2002. “Monetary Policy in Chile: A Black Box?” In *Monetary Policy Rules and Transmission Mechanisms,* edited by N. Loayza and K. Schmidt-Hebbel. Santiago: Central Bank of Chile.

Calderón, C. and F. Gallego. 2002. “La tasa de interés real en Chile.” *Economía Chilena* 5(2): 65–72.

Calderón, C. and C. Massad. 2003. “Real Exchange Rate Behavior in Chile: Exploring Long-run Trends and Short-run Deviations.” Central Bank of Chile. Mimeographed.

Cerda, R., A. Donoso, and A. Lema. 2003. “Fundamentos del tipo de cambio real en Chile.” Working paper 244, Economics Institute, Pontificia Universidad Católica de Chile.

Choudhri, E. and D. Hakura. 2001. “Exchange Rate Pass-through to Domestic Prices: Does the Inflationary Environment Matter?” Working paper 01/194. Washington: International Monetary Fund.

Clarida, R., J. Galí, and M. Gertler. 1998. “Monetary Policy Rules in Practice: Some International Evidence.” *European Economic Review* 42 (June): 1033–68.

————. 1999. “The Science of Monetary Policy: A New Keynesian Perspective.” *Journal of Economic Literature* 37(4): 1661–707.

Contreras, G. and P. García. 2002. “Estimating Gaps and Trends for the Chilean Economy” In *The Challenges of Economic Growth*, edited by N. Loayza and R. Soto. Santiago: Central Bank of Chile.

Corbo, V. 1985. "International Prices, Wages and Inflation in an Open Economy." *Review of Economics and Statistics* 67(4): 564–73.

————. 1998. "Reaching One-Digit Inflation: The Chilean Experience." *Journal of Applied Economics* 1(1): 123–63.

————. 2002. "Monetary Policy in Latin America in the 1990s." In *Monetary Policy Rules and Transmission Mechanisms*, edited by N. Loayza and K. Schmidt-Hebbel. Santiago: Central Bank of Chile.

Corbo, V. and S. Fischer. 1994. "Lessons from the Chilean Stabilization and Recovery." In *The Chilean Economy: Policy Lessons and Challenges*, edited by B. Bosworth, R. Dornbusch, and R. Labán. Washington: Brookings Institution.

Corbo, V. and K. Schmidt-Hebbel. 2001. "Inflation Targeting in Latin America." Working paper 105. Santiago: Central Bank of Chile.

Corbo, V. and J. Tessada. 2002. "Growth and Adjustment in Chile: A Look at the 1990s." In *The Challenges of Economic Growth*, edited by N. Loayza and R. Soto. Santiago: Central Bank of Chile.

De Gregorio, J., S. Edwards, and R. Valdés. 2000. "Controls on Capital Inflows: Do They Work?." *Journal of Development Economics* 63(1): 59–83.

Edwards, S. 1993. "Exchange Rates, Inflation and Disinflation: Latin American Experience." Working paper 4320. Cambridge, Mass.: National Bureau of Economic Research.

Favero, C. and F. Giavazzi. 2003. "Monetary Policy When Debt and Default Risk Are High." Bocconi University. Mimeographed.

Fischer, S. 1977. "Long-term Contracts, Rational Expectations, and the Optimal Supply Rule." *Journal of Political Economy* 85(1): 191–205.

Fuhrer, J. and G. Moore. 1995. "Monetary Policy Trade-offs and the Correlation between Nominal Interest Rates and Real Output." *American Economic Review* 85(1): 219–39.

Gallego, F., L. Hernández, and K. Schmidt-Hebbel. 2002. "Capital Controls in Chile: Were They Effective?" In *Banking, Financial Integration, and International Crises*, edited by L. Hernández and K. Schmidt-Hebbel. Santiago: Central Bank of Chile.

García, P., L.O. Herrera, and R. Valdés. 2002. "New Frontiers for Monetary Policy in Chile." In *Inflation Targeting: Design, Performance, Challenges*, edited by N. Loayza and R. Soto. Santiago: Central Bank of Chile.

García, C. and J. Restrepo. 2001. "Price Inflation and Exchange Rate Pass-through in Chile." Working paper 128. Santiago: Central Bank of Chile.

García, P. and R. Valdés. 2003. “Dinero e inflación en el marco de metas de inflación.” *Economía Chilena* 6(1): 21–47.

Greene, W. 2002. *Econometric Analysis*, 5th ed. New York: Prentice Hall.

Goldfajn, I. and S. Werlang. 2000. “The Pass-through from Depreciation to Inflation: A Panel Study.” Working paper 5. Brasilia: Central Bank of Brazil.

Hamilton, J. 1994. *Time Series Analysis*. Princeton University Press.

Kerr, W. and R. King. 1996. “Limits on Interest Rate Rules in the IS Model.” *Federal Reserve Bank of Richmond Economic Quarterly* 82(2): 47–75.

King, R. 2000. “The New IS-LM Model: Language, Logic, and Limits.” *Federal Reserve Bank of Richmond Economic Quarterly* 86(3): 45–103.

Lane, P. 2001. “The New Open Economy Macroeconomics: A Survey.” *Journal of International Economics* 54(2): 235–66.

Larraín, F. and R. Vergara. 2000. *La transformación económica de Chile*. Santiago: Centro de Estudios Públicos.

Mankiw, N.G. and R. Reis. 2002. “Sticky Information versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve.” *Quarterly Journal of Economics* 117(4): 1295–328.

Massad, C. 1998. “La política monetaria en Chile.” *Economía Chilena* 1(1): 7–28.

Mátyás, L. 1998. *Generalized Method of Moments Estimation*. Cambridge University Press.

McCallum, B. 2001. “Analysis of the Monetary Transmission Mechanism: Methodological Issues.” In *The Monetary Transmission Process : Recent Developments and Lessons for Europe*, edited by Deutsche Bundesbank. Houndmills, U.K. and New York: Palgrave.

McCallum, B. and E. Nelson. 1999. “An Optimizing IS-LM Specification for Monetary Policy and Business Cycle Analysis.” *Journal of Money, Credit, and Banking* 21(3): 296–316.

Mies, V., F. Morandé, and M. Tapia. 2002. “Política monetaria y mecanismos de transmisión: nuevos elementos para una vieja discusión.” *Economía Chilena* 5(3): 29–66.

Morandé, F. 2001. “Una década de metas de inflación en Chile: desarrollos, lecciones y desafíos.” *Economía Chilena* 4(1): 35–62.

Obstfeld, M. and K. Rogoff. 1995. “Exchange Rate Dynamics Redux.” *Journal of Political Economy* 103(3): 624–60.

Romer, D. 2000. “Keynesian Macroeconomics without the LM Curve.” *Journal of Economic Perspectives* 14(2): 146–69.

Rosende, F. 2000. *Teoría macroeconómica: ciclos económicos, crecimiento e inflación*. Santiago: Ediciones Universidad Católica de Chile.

Schmidt-Hebbel, K. and M. Tapia. 2002. "Inflation Targeting in Chile." *North American Journal of Economics and Finance* 13(2): 125–46.

Sims, C. 1980. "Macroeconomics and Reality." *Econometrica* 48(1): 1–48.

Stock, J. and M. Watson. 2001. "Vector Autoregressions." *Journal of Economic Perspectives* 15(4): 101–15.

Taylor, J. 1993. "Discretion versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy* 39 (December): 195–214.

————. 1999. *Monetary Policy Rules*. University of Chicago Press.

————. 2000. "Low Inflation, Pass-through, and the Pricing Power of Firms." *European Economic Review* 44(7): 1389–408.

Valdés, R. 1998. "Efectos de la política monetaria en Chile." *Cuadernos de Economía* 104: 97–125.

Walsh, C. 2003. *Monetary Theory and Policy*, 2nd ed. Cambridge, Mass: MIT Press.

Woodford, M. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press.