Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 243

Diciembre 2003

MODELING A SMALL OPEN ECONOMY: THE CASE OF CHILE

Vittorio Corbo José Tessada

La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: http://www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de $500 si es dentro de Chile y US$12 si es para fuera de Chile. Las solicitudes se pueden hacer por fax: (56-2) 6702231 o a través de correo electrónico: bcch@bcentral.cl.

Working Papers in PDF format can be downloaded free of charge from: http://www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for orders inside Chile the charge is Ch$500.) Orders can be placed by fax: (56-2) 6702231 or e-mail: bcch@bcentral.cl.

BANCO CENTRAL DE CHILE

CENTRAL BANK OF CHILE

La serie Documentos de Trabajo es una publicación del Banco Central de Chile que divulga los trabajos de investigación económica realizados por profesionales de esta institución o encargados por ella a terceros. El objetivo de la serie es aportar al debate de tópicos relevantes y presentar nuevos enfoques en el análisis de los mismos. La difusión de los Documentos de Trabajo sólo intenta facilitar el intercambio de ideas y dar a conocer investigaciones, con carácter preliminar, para su discusión y comentarios.

La publicación de los Documentos de Trabajo no está sujeta a la aprobación previa de los miembros del Consejo del Banco Central de Chile. Tanto el contenido de los Documentos de Trabajo, como también los análisis y conclusiones que de ellos se deriven, son de exclusiva responsabilidad de su o sus autores y no reflejan necesariamente la opinión del Banco Central de Chile o de sus Consejeros.

The Working Papers series of the Central Bank of Chile disseminates economic research conducted by Central Bank staff or third parties under the sponsorship of the Bank. The purpose of the series is to contribute to the discussion of relevant issues and develop new analytical or empirical approaches in their analyses. The only aim of the Working Papers is to disseminate preliminary research for its discussion and comments.

Publication of Working Papers is not subject to previous approval by the members of the Board of the Central Bank. The views and conclusions presented in the papers are exclusively those of the author(s) and do not necessarily reflect the position of the Central Bank of Chile or of the Board members.

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
Huérfanos 1175, primer piso.
Teléfono: (56-2) 6702475; Fax: (56-2) 6702231

Documento de Trabajo
N° 243

Working Paper
N° 243

MODELING A SMALL OPEN ECONOMY: THE CASE OF CHILE

Vittorio Corbo
Banco Central de Chile

José Tessada
Massachusetts Institute of Technology

Resumen

Este artículo presenta un modelo macroeconómico pequeño de la economía chilena. El modelo se compone de cuatro ecuaciones que capturan la evolución de las principales variables macroeconómicas: actividad, inflación, la tasa de política monetaria y el tipo de cambio real. Desde el punto de vista analítico, el modelo está expresado de manera tal que captura solo trayectorias de convergencia hacia valores de estado estacionario que no están modelados aquí, y no se pueden usar para analizar shocks que pudieran afectar la trayectoria de largo plazo de cualquier variable de interés para el análisis de política económica. El trabajo emplea el modelo para simular las respuestas dinámicas de la economía chilena a ciertos shocks externos e internos que son de interés para efectos de política monetaria.

Abstract

In this paper we present a small macroeconomic model of the Chilean economy. The model comprises four equations that capture the evolution of the main macroeconomic variables, output, inflation, policy interest rate, and the real exchange rate. Analytically, the model is expressed in a way such that only captures convergence paths toward steady state values which are not modeled in this paper, so it is not usable to analyze any shock that might affect the long-run trajectory of any variable of interest in economic policy analysis. We use the model to simulate the dynamic response of the Chilean economy to some external and internal shocks that are of interest for monetary policy purposes.

The views expressed are those of the authors and not necessarily those of the Central Bank of Chile. We have benefited from comments by and suggestions from Rómulo Chumacero, Klaus Schmidt-Hebbel, Francesco Giavazzi, Huberth Escaith, and José De Gregorio. Authors 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 to the Pontificia Universidad Católica de Chile. This version was completed while José Tessada was visiting the Research Department of the Central Bank of Chile. Usual disclaimers apply.
E-mails: vcorbo@bcentral.cl; tessada@mit.edu.

1. Introduction

During the last twenty years monetary policy design has experienced major changes. These changes have had their origin on changes in macroeconomic theory, a better understanding of the importance of achieving and maintaining low inflation and, of the abandonment of fixed pegs in favor of floating exchange rate regimes. The new models built in macro emphasize the role of micro foundations and expectations and highlight the importance and the necessity to develop and strengthen institutions. One of the key consequences of these developments has been the recognition of the failure of stabilization policy to achieve permanent gains in output or employment.

The emphasis on credibility and the appearance of explicit forward-looking expectations have resulted in important changes; among them is the recognition that monetary policy must have a forward-looking design. Given the existent lags between policy decisions and its effects on the real economy, it is necessary to contemplate not only current values but also projected values of relevant variables in the right horizon. The necessity to generate forecasts of economic variables has lead the institutions in charge of monetary policy to develop macroeconomic models appropriate for forecasting the relevant variables that condition the design of monetary policy. The available options are very wide, ranging from simple one-equation models of the most relevant variables to elaborated micro-founded models with rational expectations and a large number of relations, estimated or calibrated, that incorporate uncertainty in the solution, obtaining not only a point forecast but also a range for the key endogenous variables with a probability distribution[1]. Other 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.

Among this wide range of models, semi structural and small size models have found an increasing role in macroeconomic analysis and policy design. These models incorporate

[1] The models used in the elaboration of the monetary policy reports by most central banks that operate under an inflation targeting framework are a good example of these models. See for example the Central Bank of Chile's Monetary Policy Reports available on the web (www.bcentral.cl) and Bank of England (1999) for a description of the wide range of models they use.

reduced form equations that can be obtained from explicit solution of micro-founded models. Although these models are not immune to the Lucas' critique they are robust enough to deal with monetary policy changes and other shocks related to it. The use of small models reduces the details but have important advantages in terms of easier and faster solution and intuition. There are a lot of models of this type[2], and some of them have been evolving from old traditional models, incorporating new theoretical and empirical features.

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 the Chilean economy.

The paper is organized as follows. The next section presents a brief discussion about macroeconomic models and monetary policy analysis, and a short, and certainly incomplete, review of macro models of the Chilean economy presented in recent years. The third section presents and briefly discusses 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 fourth section analyzes the simulations and its results. Finally, section five presents the main conclusions.

2. Macro Models for Monetary Policy Analysis in Chile

As to provide a simple organizing framework to think about macroeconomic models, we will introduce a very brief and sketchy summary about the current state of macro models and some of the recent applications presented 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. Good examples of its orientation can be found in Kerr and King (1996), Clarida at al (1999), McCallum and Nelson (1999) and McCallum (2001).

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

Macro Models and Monetary Policy: A brief explanation

Modern macro models for monetary policy analysis build up on the tradition of the IS-LM-AS type of models, but with several important modifications that mostly update them so as to incorporate recent theoretical advances and important changes in the way economic policy is implemented[3]. However, there is a lot of heterogeneity among them with respect to the degree of consistency to specific models, in other words, not all the models are clearly derived from explicit microfoundations 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. There is no clear answer about what model is the most appropriate, but in fact it depends on the question you are interested in the model you might want to use.

Macroeconomic models used to analyze 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 with forward looking expectations, and small non-structural models of the VAR type[4]. The first class of models is usually derived from first principles and incorporates lots of detail, with explicit budget constraints and first order conditions, and rational expectations are used in simulations; one of its main advantages is that when derived from first principles, all the parameter restrictions are imposed, and expectations are derived consistently within the model, the results are robust to the Lucas critique. Following McCallum (2001), we can say that structural models have to have parameters that are invariant to policy changes and for this purpose they have to be derived from micro foundations and have to have forward looking expectations. The main disadvantage of this type of models is the poor tracking of the short run dynamics[5]. An important example of this class of models is the real business cycles (RBC) type of models. Although not designed to track the short run evolution of the

---

[3] The increasingly common use of interest rates as instruments of monetary policy lead some researchers to change the traditional IS-LM specification for a new description named IS-MP model by Romer (2002).

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

economy, in the case of Chile, these models have been applied in order to match correlations and other regularities of the Chilean business cycles. However, as in most developing countries, the use of RBC models has been limited and only during the recent years more research on this area has been carried out.

However, an important part of the research has made use of other class of large scale models, which are not derived from first principles but are built up using several empirical relationships that incorporate ad-hoc specifications, in order to track more closely the movements in some macro aggregates, of course most of this modifications do not explicitly come from microfounded models. These models do describe a large number of variables that are then used to compute aggregate variables. Its 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. Very useful for policy purposes, the size is a disadvantage when some questions related to specific issues must be answered quickly or simple answers are enough.

The second type of models has proved to be very useful for monetary policy analysis. Its ability to capture the main elements of an economy plus its simplicity allows researchers and policymakers to be able to answer simple questions without the necessity of dealing with too detailed specification. As in the previous case, 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 estimation purposes, although calibrated models can be easily constructed so as to reflect results for different choices of deep behavioral parameters[6]. Interpreted usually as the result from dynamic neokeynesian models, they incorporate rational expectations and, in general, also emphasizes the explicit role of (the expected values of) forward looking variables. In a widely cited work, Clarida et al. (1999) present an analysis of monetary policy using a simple model of this type as their framework showing the basis of the research in this area.

---

[5] See King (2000) and Woodford (2002) for reviews of the core structure of this type of models. Lane (2001) presents a review of the basic structure of the New Open Economy Macroeconomics type of models, a seminal contribution on this line is Obstfeld and Rogoff (1996).

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. There is no mayor questioning about the choice of an IS equation for describing aggregate demand, specific issues regarding timing and inclusion of forward looking variables have important theoretical considerations, but empirical works tend to choose according to goodness of fit more than strict theoretical underpinnings. Regarding the monetary policy specification, these models, as most of the research about monetary policy has done since Taylor (1993), usually include a Taylor's reaction function describing the behavior of monetary authorities[7].

The most important and controversial element is the pricing or aggregate supply equation; there is no questioning among economists about the characteristics of the long-run supply curve, but when talking about the short-run specification things are not clear. The first problem relates to the long lasting debate between new classical and new Keynesian specifications, which we do not expect to solve here[8]. However, another important issue comes from the empirical fact that the inflation rate exhibits significant inertia but none of the traditional models generates inflation inertia, just price level inertia is derived from those specifications. This is not a minor issue in what inflation inertia is closely related to the idea of disinflation processes being costly in terms of output and employment; different approaches have been tried, however there is no clear consensus about a close and clear theoretical way to solve it; Fuhrer and Moore (1995) presented and early approach, and Mankiw and Reis (2002) developed a nice and interesting approach which can be related to early work by Fischer (1977).

The third type of models is increasingly used to analyze the effects of key endogenous variables (output, inflation, unemployment) of unexpected or unsystematic shocks in policy variables or in exogenous variables. Its popularity increased after Sims

---

[6] Walsh (2003) presents some of the models of this type that are in use nowadays.

[7] In fact, one of the main uses of these simple models is to analyze robustness of different policy rule specifications under different parameterizations of the model.

[8] Recently updated reviews of these models can be found in Rosende (2000), Woodford (2003) and Walsh (2003).

(1980) critique of the ad-hoc specifications of the models used by this time, its main characteristic is the absolute lack of predetermined structure and all the relations are derived from the time series specification that can be used to derive simple and very intuitive results, like the impulse responses and the variance decomposition figures[9]. Of course its simplicity explains all the advantages and disadvantages we can think of, however when wisely used VAR models could provide very useful insights about dynamic properties and simple description of co-movements between different economic series.

A Brief Survey for Chile

During the last 15 years the literature about economic policy and economic performance has become one of the most active in Chile. The fact of being an early reformer transformed the country in the model that most think tanks and institutions studied so as to develop a general framework for guiding reforming efforts in other developing countries. Among this research, important questions about the role played by monetary, exchange, and fiscal policy in the rapid recovery and stabilization of the country after the severe crisis of the 1970s and 1980s were initially at the center of the macro economic research. Since then, several new issues have come to the front 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, not the single objective but the most important one[10]. With the abandonment of the exchange rate band after the Russian and Brazilian crisis and the achievement of a low inflation level in 1999 new questions emerged. The increasing integration to international financial markets and the already high dependency to the evolution of the 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 models usable for

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

[10] For a review of monetary policy and the Chilean economy during the late 1970s and 1980s see Corbo and Fischer (1994). Reviews of monetary policy during 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 et al (1994) and Larraín and Vergara (2000).

economic policy analysis. The available literature on the topic is growing very fast meaning that presenting an exhaustive survey is whole challenge on its own and impossible to do in a brief section. As an introduction to the previous literature we will review six papers, Bergoeing et al (2002a), García et al (2002a), Corbo and Schmidt-Hebbel (2001), Corbo and Tessada (2002), Valdés (1998), Cabrera and Lagos (2002), and Mies et al (2002)[11].

Bergoeing et al (2002a) present a calibrated growth model, which is used to explain differences between Chile and Mexico after the debt crisis. The model is used to account for possibly 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, but not the traditional reforms claimed by most authors, they mention banking and bankruptcy laws as key elements explaining the different patterns.

Garcia et al (2002a) is a large scale model, constructed for monetary policy analysis at the Central Bank of Chile. Using calibrated and estimated equations the model is built in blocks, each describing different sectors of the economy, which are then aggregated and allow to model different monetary policy transmission channels. In particular, not all the equations have been derived from first principles and there are almost no cross equation restrictions on the parameters. Main features of the model are the very detailed external sector, justified by its great influence on the evolution of the Chilean economy, and the production block, built accordingly to a Cobb-Douglas production function capturing 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 and permanent shocks; when possible, the responses are contrasted to the ones obtained from a simpler model and a VAR model. The results are relatively similar, but the model account for the responses with greater detail and allows the analysis of shocks that might affect the steady state values, feature not present in any of the other models presented by the authors.

[11] If the reader is interested in more detailed surveys, Duncan (2002) presents a more detailed review of RBC models calibrated for the Chilean economy since 1990. In VAR models Cabrera and Lagos (2002), Mies et al (2002), and Chumacero (2002) discuss more papers that use a VAR methodology. Gallego et al. (2002a) show a large scale dynamic macroeconomic models derived from first principles; a mixture of estimated and calibrated formulas are used for simulation.

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 tests and imposes homogeneity in nominal variables in the price and wage equations ensuring a vertical long run Phillips curve. The model is simulated then under counterfactual scenarios to try to shed some light on the role played by credibility and the inflation target on the sustained reduction of inflation experienced by Chile during the 1990s. They answer that the introduction of the target helped in anchoring expectations and the gradual approach allowed the authorities to reduce inflation without the large cost that would have been observed under a cold-turkey approach. The model does not explicitly model the steady state and so it is not capable of answer questions related to shocks or policy changes that might affect the real equilibrium of the economy in the long run. In fact, in the analysis presented by the authors the underlying assumption is that any change in the inflationary regime or the monetary policy framework is not causing a significant change to the long run output level.

Corbo and Tessada (2002) make use of a very similar model with some slight modifications and of a non-structural VAR to assess the importance of different factors that might account for the 1998-1999 slowdown of the Chilean economy. The non-structural 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 crises periods to inspect the role played by different factors, including the monetary policy response, in the subsequent activity slowdown of 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, but even after taking into consideration the external factors, part of the slowdown can be blamed on a severe anti inflationary attitude from the Central Bank.

Valdés (1998) estimates a “semi-structural” VAR model in which he makes assumptions that allow him to identify the monetary policy shocks without adding more structure to the VAR, and so the rest of the shocks are not studied in the paper. After reviewing the literature on VAR model existent by this time, the author present his own results where introduces a modification respect to previous work, instead of using the inflation rate itself it argues that monetary policy affects in fact the gap between the inflation rate and the target. When using the modified specification he founds that monetary policy has significant effects on both the inflation gap and the monthly activity index (IMACEC)[12].

Cabrera and Lagos (2002) use structural VAR models to compare alternative hypothesis about monetary policy transmission mechanisms. The analysis is carried out by estimating a different VAR model for each of the competing hypothesis. They conclude from their analysis that there is weak evidence of price puzzle result in Chile, but that spending and output do not significantly respond to the interest rate but instead they show significant responses to nominal money supply. They interpret this as a possible questioning to 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.

Mies et al (2002) make use of single equation and VAR models to analyze the effectiveness of monetary policy during the 1990s. The single equation analysis estimates an equation relating the 12-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 later variable is identified as the residuals from the estimation of a monetary policy function. They found evidence of a change in the effectiveness of monetary policy, identified as the coefficient of the monetary shock in the regression; but looking at the non-systematic part of monetary policy implies that a significant part is left out of the analysis, and so no answer is given for the effect of the systematic (expected?) portion of monetary policy actions[13]. They then move to the analysis 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 sectoral monthly indicators they estimate VAR models to study the effect of monetary policy on different

[12] A quite counterintuitive point of his approach is the fact that he extends the data on the target for the 1980s using the forecasts published by a private forecaster, which by its own nature cannot be considered as playing the same role in the economy. A quite different approach is followed by Corbo and Schmidt-Hebbel (2001) where they show that when the inflation target is included into a non-structural VAR model, the dynamic forecasts are closer to the forecasts published by Consensus Forecasts for the corresponding periods; they interpret this as evidence of a the targets anchoring inflation expectations.

economic sectors, showing that construction and manufacturing are the sectors that are 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.

3. The Model

As we explained in the previous section, since the 1980s there has been an important line of research that make use of different types of models to analyze different questions about the Chilean economy[14]. Our model is related with most of the literature that deals with macroeconomic analysis of the country, in particular with several papers that have addressed issues related to monetary, exchange rate and disinflation policies since the early experiments during the late 1970s.

During the last five years many papers explored monetary policy considerations under the IT framework. Most of them 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 à la Salter-Swan-Dornbusch-Corden, but are expanded to incorporate new elements based on more recent empirical and theoretical developments. Some examples of this model are Edwards (1993), Corbo (1985), Corbo and Fisher (1994), Corbo and Schmidt-Hebbel (2001) and Corbo and Tessada (2002).

One of the important questions when working with models is to answer the relevant questions. In this case our interest 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 et al. (2002a) identify seven stylized facts about the Chilean economy; of these seven stylized facts we directly model two -the sensitivity of the domestic cycle to external conditions and the combination of inflation rate, inflation targets and economic cycle- while the other five are not explicitly modeled because of our focus on the short run or the assumption that the long-run equilibrium is exogenous to

---

[13] See Bernanke et al (1997) for a study addressing the importance of the systematic component of monetary policy in the case of the US.

our model[15]. In general, it is our perception 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 more complicated and larger model[16].

The main equations of the model consist of an IS equation explaining the evolution of the domestic output gap, a transition equation linking the evolution of the real exchange rate (RER) to other exogenous and endogenous variables, an inflation equation that can be related to the Fuhrer-Moore specification for pricing equation in the US[17] and a Taylor rule describing monetary policy. Each equation was estimated separately in order to avoid spill over 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 relating domestic output gap to internal and external demand factors[18]. An important role is played by external factors, in fact, the coefficients for the output gap of the main trade partners (foreign output gap from now on), the real exchange rate and the capital inflows are statistically significant and the magnitude of the impact effects are relevant too. As in any model it is very plausible to consider that the capital inflows are endogenous to the output gap, a measure of the availability of flows to the Chilean economy is used instead of the capital inflows. This measure is constructed by adding up the supply of external funds from the US, the Euro area and Japan and then dividing the sum by the total output of the three countries, a measure that can be considered to be exogenous. The importance of the capital flows in the evolution of the domestic output gap can be linked to the "sudden stop" hypothesis, and in particular with Caballero (2002) argument that the connection between developing countries

---

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

[15] Even if it looks too heroic, this assumption is very useful when analyzing responses to transitory shocks. However, it also restricts 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).

[16] García et al (2002a) contrast their results with the results derived from a VAR model and a smaller structural model.

[17] See Fuhrer and Moore (1995).

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

and capital flows is through quantities more than through interest rates. Obviously this evidence does not represent a careful analysis of the hypothesis, but it sheds some light into the problem[19]. It must be mentioned that we are not estimating a neo-Keynesian version of the IS equation because the expected future level is not included as an explanatory variable, condition that is derived from intertemporal optimization.

The only internal variable considered in the specification is the real monetary policy rate, expressed as deviation from an equilibrium value that is not restricted to be a constant over time[20]. This value also corresponds to the steady state equilibrium of the monetary policy rate, and so it can be interpreted to be the "natural" interest rate. It must be noted that we do not differentiate between short and long interest rates, a simplification that allows us to keep the model very simple at the cost of loosing detail about the effect of short rates on long rates and its effect on real activity. An alternative specification was also estimated, including as an additional explanatory variable the terms of trade (instead of the real exchange rate) but there are no significant changes in the results. Equation (1) shows the estimated open economy IS equation for the Chilean economy.

$$(1) \quad \underset{}{y_t} = \underset{(0.114)}{-0.002} + \underset{(0.256)}{0.512 y^*_{t-2}} + \underset{(0.036)}{0.079 rer_{t-3}} + \underset{(0.259)}{1.151 capflows_{t-1}} - \underset{(0.086)}{0.276 tpmr_{t-2}} + \underset{(0.057)}{0.737 y_{t-1}}$$

OLS estimation, Newey-West robust standard errors reported in parenthesis.

Sample: 1987:1-2002:4

R^2 = 0.91; LM test (1) = 0.276 (p-value: 0.601)

The following equation in the model corresponds to the monetary policy reaction function. The dependent variable is expressed as deviation with respect to an equilibrium

[19] This is a very interesting topic that probably needs more attention from an empirical point of view.

[20] Calderón and Gallego (2002) present a discussion about the "natural" interest rate for the case of Chile.

value, which also corresponds to the steady state equilibrium of the interest rate in the model. As it was explained before, this value is not assumed to be constant over time[21].

The estimation of an equation like equation (2), as it is explained in Clarida et al. (1998) and in Corbo (2002), is more complicated because two right hand side variables depend on the observed values of the interest rate. Following previous work on the issue, generalized method of moments (GMM) is used 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 90-day Central Bank bills (the PRBC-90) we use a hybrid variable called policy rate, which consists of the PRBC-90 up to April 1995, and since then it is replaced by the "tasa de instancia". However, as it is showed in Corbo and Tessada (2002), during 1998 in some specific months this rate was not a clear sign of the true monetary policy stance[23]. To solve this problem we replaced these values by the PRBC-90 rate, and then we 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 estimated the policy function for the 1990s with the current account as an alternative object for the Central Bank, as it was explicitly recognized by the authorities of the time[24]. However, after 1998 the orientation of monetary policy has changed, thus we modified the specification by including the output gap as the other variable. The results are relatively satisfactory, but it seems too soon to derive hard conclusions about the new structure of the policy function[25].

---

[21] The equilibrium value was computed by subtracting moving averages to 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 in this procedure. The version of the equation (2) presented in the paper corresponds to the deviation computed using the HP filter.

[22] For a review of generalized method of moments see Hamilton (1994), Greene (2002) and Matyas (1998). For a review of previous works about estimation of monetary policy reaction functions, see Clarida et al. (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 Corbo (2002) and Corbo and Tessada (2002) for previous estimations of monetary policy reaction functions for the 1990s.

[25] The model was also estimated under the assumption that the Central Bank only responds to the inflation rate and the output gap is only a variable of interest because of its effect on the inflation rate.

$$(2)\qquad \underset{}{tpmr_t} = \underset{(0.102)}{0.539}(p - tar)_{t+3} + \underset{(0.019)}{0.067}\, y_t - \underset{(0.059)}{0.561}\, tpmr_{t-1}$$

GMM estimation; weighting matrix is robust to heteroskedasticity and autocorrelation; robust standard errors are shown in parenthesis.

Sample: 1995:1-2002:1; Instruments: lags of the right hand side variables and lags of external inflation.

$R^2 = 0.855$

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: external inflation (reflected in the real exchange rate misalignment), internal inflationary pressures (summarized in the output gap), forward looking expectations (incorporated through market expectations or through leads of core inflation), and persistence in the inflation rate, due to indexation or measurement[26]. Despite a growing evidence that exchange rate pass-through is not constant over the cycle and likely depends on more variables we do not explore major deviations from our simple linear specification here as in our first explorations we are not able to identify any interactive or non-linearity in the specification that could be associated to a non-constant pass-through[27]. However, other authors have been able to find such kind of effects in the Chilean economy under different specifications and with different purposes, see García and Restrepo (2001), and Schmidt-Hebbel and Tapia (2002).

The forward looking component of the inflation equation was modeled in two different ways. Our first version incorporates as forward looking variable the expected

[26] Our dependent variable is the 4-quarter rate of change of core price index (IPCX in the Chilean Central Bank nomenclature).

[27] Taylor (2000) explains how to rationalize a correlation between lower inflation variability and lower exchange rate pass-through. Choudhri and Hakura (2001) tested 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 the idea about permanent and transitory effects derived by Taylor (2000). Goldfajn and Werlang (2000) present a comprehensive study analyzing possible determinants of the magnitude of the pass-through.

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 then is modeled in a way that simply reflects a slow adjustment of expectations[28]. The second version assumes rational expectations, and so as a proxy for expected inflation we use the effective future inflation rate (with the corresponding leads matching the timing of the previous version); under rational expectations we can use GMM and estimate the equation using as instruments variables that are known today and are useful for forecasting purposes. This specification includes then model consistent expectations. With respect to lagged inflation, we incorporated two lags of inflation, and they were selected in order to avoid autocorrelation of the residuals.

(3')
$$p_t = \underset{(0.031)}{0.068} rer_{t-1} + \underset{(0.040)}{0.096} y_{t-1} + \underset{(0.083)}{0.175} E_{t-1}^{M}(p_{t+1}) + \underset{(0.207)}{1.117} p_{t-1} - \underset{(-)}{0.292} p_{t-2}$$

OLS estimation, Newey-West robust standard errors reported in parenthesis.

Sample: 1991:1-2002:4

R^2 = 0.96; LM test (1) = 2.13 (p-value: 0.15)

(3'')
$$p_t = \underset{(0.032)}{0.058} rer_{t-1} + \underset{(0.028)}{0.044} y_{t-1} + \underset{(0.035)}{0.210} p_{t+1} + \underset{(0.183)}{1.061} p_{t-1} - \underset{(-)}{0.271} p_{t-2}$$

TSLS estimation; Newey-West robust standard errors reported in parenthesis.

Sample: 1991:1-2002:1; Instruments: lags of the right hand side variables, lags of core inflation, lags of the inflation target and lags of external inflation.

R^2 = 0.98; LM test (1) = 2.23 (p-value: 0.14)

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

The only puzzling element is the important change in the value of the parameter that measures the effect of the cycle when the market expectation is replaced by the observed rate. The change cannot be blamed on an endogeneity problem because the parameter values when equation (3') is estimated using TSLS do not significantly differ from the ones presented here using OLS. One possible exploration might be a feedback from the right hand side variables into expectations or into leads of the inflation rate; an additional explanation can be a problem with the instruments in the TSLS estimation. In spite of 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 the inflation expectations.

We now turn to the main variable that connects the external sector with the evolution of domestic variables, the real exchange rate. In the model we use the definition the real exchange rate relative to the main industrial trade partners, namely United States, Japan, United Kingdom, Canada, and the members of the Euro area. The real exchange rate is the main variable reflecting the evolution of the external sector; the selected specification includes as explanatory variables of the gap between the observed RER and a long-run value[29] the domestic output gap and lagged values of the RER deviation. Alternative specifications include the difference between the domestic output gap and the foreign output gap, and the terms of trade (as log deviation from a long run value), but the results do not significantly change. A different approach is to impose interest rate parity and include additional variables, but the use of very detailed and specific capital controls –which also changed during 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].

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

TSLS estimation, Newey-West robust standard errors reported in parenthesis.

[29] This long-run value is also the steady state equilibrium of the RER in this model.

[30] Two recent reviews of the Chilean experience with capital controls are Gallego et al (2002b), and De Gregorio et al. (2000).

Instruments: lags of right hand side variables, lags of RER gap, and lags of foreign output gap and capital flows.

Sample: 1986:1-2002:4

$R^2 = 0.45$; LM test (1) = 0.82 (p-value: 0.37)

LM test (4) = 1.18 (p-value: 0.88)

The short run specification of the RER must be interpreted carefully because we do not include any nominal variable that are known to be important when forecasting the RER in the short-run[31]. As in most of the literature of macroeconomic models for Chile, the short run evolution of the RER follows an ad-hoc specification; particularly our definition intends to capture movements of the RER that are associated with "medium run"[32] deviations and do not necessarily follow short-run volatility from the exchange rate market[33]. This assumption is relevant for the interpretation of the simulations presented in the next section; the focus on more permanent movements of the RER means that in our model changes associated with short-run volatility will not generate a response in the output gap nor in the inflation rate, and in fact, these short run fluctuations are not even modeled in this paper. It is clear then that we assume that transitory deviations do not imply an acceleration of inflation, but in real situations we always might answer whether an observed change is transitory or volatility[34], and so, its effect is not clear until its nature is realized by the agents.

A different approach is postulated in Blanchard (2003)[35]. Under certain assumptions about imperfect capital mobility he is able to obtain an "expanded" parity condition which allows for a slightly different specification with respect to the traditional uncovered interest

---

[31] Three recent papers on the topic for Chile are Gallego et al (2002b), Calderón and Massad (2003), and Cerda et al. (2003).

[32] Where medium run could be interpreted as a period long enough so real variables tend to be more important for explaining real exchange rate fluctuations. This period does not need to be as large as the medium life of PPP shocks.

[33] See three different approaches in Garcia at al (2002a, b), Gallego et al. (2002a), and Corbo and Tessada (2002).

[34] See the references given early in the paper for a discussion about exchange rate pass-through and evidence for Chile and other countries.

[35] This is the equation used by Favero and Giavazzi (2003) for a study about the effects of non-ricardian fiscal policies in Brazil.

rate parity, explicitly incorporating the sovereign risk premium without imposing more conditions in the value of the parameters of the equation.

The equations presented in the previous paragraphs constitute the core block of the model, apart from it 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.

4. Simulation Exercises

In this section we use the model already presented to explore the impact of external shocks in the Chilean economy. This has been a key question in the policy and academic economic debate during recent years as it is a well known fact the high impact the external cycle has on domestic output, nevertheless a clear characterization of the dynamic effects has not been addressed until very recent[36]. It is also interesting the analysis of the dynamic response of the economy to some internal shocks, especially inflation shocks that might come from changes in regulated prices or some other change that might generate an exogenous acceleration of the inflation rate. Our model presents a simple and easy-to-use alternative for this purpose as it captures most of the short-run issues in a very simple framework[37].

We will analyze three different shocks to the Chilean economy: an inflation shock, a foreign output gap shock, and a capital inflows shock. These three shocks reflect most of the variables that are relevant for monetary policy in the current years in Chile. In particular 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 the model as it was presented and incorporating equation (3’) for the inflation rate; the second, replaces equation (3’) by a calibrated relation that changes the weights on the forward looking and backward looking

[36] The papers summarized in section 2 provide a fairly good coverage of the current state of the research on this topic.

[37] García and Valdés (2003) present a very similar model to illustrate the interaction of money and inflation under the inflation targeting framework currently in use in Chile. However they do not present estimations of their model.

elements, in particular it changes the coefficient on the expected inflation to 0.7 –while lowering the coefficient on lagged inflation to 0.3.

The structure of the simulation is as follows. We set as the initial values for all the endogenous and exogenous variables (and the market inflation expectations when used) equal to the 2001-2002 average value and simulated the model forward using simple autoregressive processes for the exogenous variables; this simulation gives us the benchmark to compare the effect of al the shocks[38]. We then redo the simulation, but now the shocks are incorporated in the model; in particular the inflation rate shock is defined as a 0.5% higher inflation rate in the initial period, while the shocks to the foreign output gap and the capital inflows are defined as a reduction equivalent to a one standard deviation computed using the entire sample, this implies a shock equal to a 0.5% for the foreign output gap and to a 0.67% for the capital inflows. All the shocks are defined to be transitory, and we report only the effects when the shocks are allowed to show persistence or autocorrelation, in fact, qualitatively the results are similar, with significantly lower persistence if we do not incorporate the autoregressive specifications for the external variables in the model[39].

Let us turn now to the description of our results. As can be seen on Figure 1, 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. Monetary policy endogenously responds to both effects and shows a significant reduction. Comparatively, the effect of the foreign output is of a reduced magnitude with respect to the capital flows shock, something that could be inferred by simple inspection of the coefficients in the IS equation. Furthermore, the propagation mechanism appears in the graphs with the external variables affecting first the output gap and then the inflation rate, of course, monetary policy reacts to both effects lowering the real rate in response to a reduced domestic activity and taking advantage of the room created by the low inflationary pressures.

---

[38] An alternative way to simulate the model is the more traditional one of assuming that the model is in the steady state and then apply the shocks, given the structure of the model, the solutions do not significantly differ. A different approach 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 with the shocks and starting from this steady state, this is the approach followed by Gallego et al (2002a).

The effects are relatively important, in Figure 1 Panel (a) can be observed that after three quarters the effect on the domestic output gap of the capital flows shock is 1.1% (of the potential output), while the maximum effect in the case of the foreign output gap is 0.32% and is reached three quarters after the shock. For the inflation rate, the maximum effects are observed only six quarters after the shocks, reflecting the propagation from output to inflation of these aggregate demand shocks (see Figure 1, Panel (b)).

Monetary policy is the variable that in this case results to be the most endogenous of all the variables under analysis. Initially responds to the reduction in the domestic output gap, but it is only when the inflation rate starts to go down 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 only 4 to 5 quarters after the shock happened, but the response started to build up since the shocks are observed, emphasizing the forward looking behavior of monetary policy (Figure 1, 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 macro economy. 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.

For the case of the inflation rate shock, the results using the model are presented in Figure 2. The series labeled as Original correspond to the solution when the 0.5% shocks is simulated using equation (3’). We can observe (Figure 2, Panel (b)) that inflation rate reaches its peak the two semesters right after the shock. The subsequent evolution reflects the important inflationary inertia found in the specification and also the parsimonious response from monetary policy to the shock. The effect disappears 7 to 9 quarters after the shock, but by the fourth and fifth quarter about half of the effect has already disappeared. A key role is played by inflation expectations, which anchor the evolution of the observed inflation rate to the target rate set by the central bank, assumed to be 3% for the simulations.

---

[39] The results for these simulations are available upon 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.

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 5 quarters after the shock. This reduction in domestic activity must occur because of the increase in the interest rate as there is no direct connection from the shock to aggregate demand. In fact, if we simulate the same shock but instead of using equation (2) we use a simple time series process that do not allow for endogenous response of monetary policy to the inflation rate, then this effect on output vanishes[40].

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)). There is not much to say about its dynamics, given the acceleration in the inflation rate, monetary policy reacts in advance so as to put a break on it through its effect on domestic output[41].

In order to explore the relevance of the inflation inertia in the dynamics of the economy, we construct a counterfactual exercise replacing equation (3') by 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 with blue lines. The inflation rate shows exactly the same impact effect, but its persistence is significantly lower and after two or three quarters is almost zero. Of course this difference implies significant differences for the rest of the variables. With the reduced endogenous persistence on inflation, monetary policy shows a very mild response, which looks similar to the previous one, but the scale is about 15 times smaller than the used for the original simulations. In this case, a very short lived response of about a couple of basis points corresponds to the peak on the policy rate. Of course, the mapping into the output gap is obvious, with a very low inflation inertia, the small reaction by the monetary authorities

[40] In fact this comes from the implicit structure for the markup assumed in the pricing equation estimated in the model. If we allow for cost pressures on the production decision, then this result is no longer valid.

[41] Given that we could not find an interest rate effect on the RER, and that we did not impose the 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.

means that domestic output gap shows almost no effect. Hence, we found the expected results, 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 out base specification with market expectations, and so our results are not a particular feature of our particular specification for the inflation equation.

5. Conclusions

We have built a small macroeconomic model of the Chilean economy to analyze the dependence the evolution of economic activity to the external environment. From the simulation results two main findings emerge. First, the high dependence of the Chilean economy to the external environment is confirmed by the counterfactual exercises. Each shock analyzed generates non-negligible effects on the economy. Relatively modest reductions in capital inflows and external activity can generate relatively important effects in the output level, the effect of the capital inflows seeming to be particularly important. This dependence is to be expected given the high degree of openness of the Chilean economy, as international trade and external financing are important relative to the size of the economy.

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

Possible areas of further research include a empirical study of the effects of capital inflows in aggregate demand, and the 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*, September, available at the Bank's of England website.

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), January, pp.: 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), pp.: 91-157.

Blanchard, O. (2003); "Fiscal Dominance and Inflation Targeting. Lessons from Brazil", mimeo, MIT, June.

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

Cabrera, A. and L. Lagos (2002); "Monetary Policy in Chile: A Black Box?", in N. Loayza and K. Schmidt-Hebbel eds., *Monetary Policy Rules and Transmission Mechanisms.* Santiago: Central Bank of Chile.

Calderón, C., and F. Gallego (2002); "La Tasa de Interés Real en Chile", *Economía Chilena*, 5 (2), August, pp.: 65-72.

Calderón, C., and C. Massad (2003); "Real Exchange Rate Behavior in Chile: Exploring Long-Run Trends and Short-Run Deviations", mimeo, January, Central Bank of Chile.

Cerda, R., A. Donoso, and A. Lema (2003); "Fundamentos del Tipo de Cambio Real en Chile", *Working Paper 244*, Instituto de Economía, Pontificia Universidad Católica de Chile, June.

Choudhri, E., and D. Hakura (2001); "Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?", *IMF Working Paper* 01/194, December.

Chumacero, R. (2002); "A Toolkit for Analyzing Alternative Policies in the Chilean Economy", paper presented at the Central Bank of Chile Conference on General Equilibrium Models of the Chilean Economy, April 2002, Santiago, Chile.

Clarida, R., J. Galí, and M. Gertler (1998); “Monetary Policy Rules in Practice: Some International Evidence”, *European Economic Review*, XLII, pp.: 1033-1068.

Clarida, R., J. Galí, and M. Gertler (1999); “The Science of Monetary Policy: A New Keynesian Perspective”, *Journal of Economic Literature*, XXXVII (4), pp.: 1661-1707, December.

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

Corbo, V. (1985); “International Prices, Wages and Inflation in Open Economy”, *Review of Economics and Statistics*, 67, pp.: 564-573.

Corbo, V. (1998); “Reaching One-digit Inflation: The Chilean Experience”, *Journal of Applied Economics*, 1 (1), pp: 123-163.

Corbo, V. (2002); “Monetary Policy in Latin America in the 1990s”, in N. Loayza and K. Schmidt-Hebbel eds., *Monetary Policy Rules and Transmission Mechanisms*. 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*, ed. by B. Bosworth, R. Dornbusch, and R. Labán. Washington, DC: The Brookings Institution.

Corbo, V., and K. Schmidt-Hebbel (2001); “Inflation Targeting in Latin America”, *Central Bank of Chile Working Paper* 105, September.

Corbo, V., and J. Tessada (2002); “Growth and Adjustment in Chile: A Look at the 90’s”, in N. Loayza and R. Soto eds., *The Challenges of Economic Growth*. Santiago: Central Bank of Chile.

Cunningham, A. and A. Haldane (2000); “The Monetary Transmission Mechanism in the United Kingdom: Pass-Through and Policy Rules”, *Central Bank of Chile Working Paper* 83, October.

De Gregorio, J., S. Edwards, and R. Valdés (2000); “Controls on Capital Inflows: Do They Work?”, *Journal of Development Economics*, 63 (1), October, pp.: 59-83.

Dhar, S., D. Pain and R. Thomas (2000); "A Small Structural Empirical Model of the UK Monetary Transmission Mechanism", Manuscript, Bank of England.

Duncan, R. (2002); "How Well Does a Monetary Dynamic Equilibrium Model Account for Chilean Data?", paper presented at the Central Bank of Chile Conference on General Equilibrium Models of the Chilean Economy, April 2002, Santiago, Chile.

Edwards, S. (1993); "Exchange Rates, Inflation and Disinflation: Latin American Experience", NBER Working Paper 4320, April.

Favero, C., and F. Giavazzi (2003); "Monetary Policy when debt and default risk are high", mimeo, Bocconi University, April.

Fischer, S. (1977); "Long-Term Contracts, Rational Expectations, and the Optimal Supply Rule", *Journal of Political Economy,* 85 (1), February, pp.: 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), March, pp.: 219-39.

Gallego, F., L. Servén, and K. Schmidt-Hebbel (2002a); "General Equilibrium Dynamics of Foreign Shocks and Policy Changes in Chile", paper presented at the Central Bank of Chile Conference on General Equilibrium Models of the Chilean Economy, April 2002, Santiago, Chile.

Gallego, F., L. Hernandez, and K. Schmidt-Hebbel (2002b); "Capital Controls in Chile: Were They Effective?", in L. Hernandez and K. Schmidt-Hebbel eds., *Banking, Financial Integration, and International Crises*. Santiago: Central Bank of Chile.

García, C., and J. Restrepo (2001); "Price Inflation and Exchange Rate Pass-Through in Chile", *Central Bank of Chile Working Paper* 128, November.

García, C., P. García, I. Magendzo, and J. Restrepo (2002a); "A Medium-Sized Macroeconometric Model of the Monetary Transmission Mechanism in Chile", mimeo, Central Bank of Chile.

García, P., and R. Valdés (2003); "Dinero e Inflación en el Marco de Metas de Inflación", Economía Chilena, 6 (1), April, pp.:21-47.

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

Greene, W. (2002); *Econometric Analysis*, 5th Edition, New York, NY: Prentice Hall.

Goldfajn, I., and S. Werlang (2000); "The Pass-through from Depreciation to Inflation: A Panel Study", *Banco Central do Brasil Working Paper* n°5, July.

Hamilton, J. (1994); *Time Series Analysis*, Princeton, NJ: Princeton University Press.

Hargreaves, D. (1999); "SDS-FPS: A Small Demand-side Version of the Forecasting and Policy System Core Model", *Reserve Bank of New Zealand Discussion Paper* G99/10, December.

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

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

Lane, P. (2001); "The New Open Economy Macroeconomics: A Survey", *Journal of International Economics*, 54 (2), August, pp.: 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), November, pp.: 1295-1328.

Massad, C. (1998); "La Política Monetaria en Chile", *Economía Chilena*, 1 (1), April, pp.: 7-28.

Matyas, L. (1998); *Generalized Method of Moments Estimation*. Cambridge, MA: Cambridge University Press.

McCallum, B. (2001); "Analysis of the Monetary Transmission Mechanism: Methodological Issues", in Deutsche Bundesbank, *The Monetary Transmission Process : Recent Developments and Lessons for Europe*. Houndmills, Uk 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), pp.: 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), December, pp.: 29-66.

Morandé, F. (2001); "Una Década de Metas de Inflación en Chile: Desarrollos, Lecciones y Desafíos", Economía Chilena, 4 (1), April, pp.: 35-62.

Obstfeld, M., and K. Rogoff (1995); "Exchange Rate Dynamics Redux", *Journal of Political Economy*, 103 (3), June, pp.: 624-60.

Romer, D. (2000); "Keynesian Macroeconomics without the LM Curve", *Journal of Economic Perspectives*, 14 (2), Spring, pp.: 146-69.

Rosende, F. (2000); *Teoría Macroeconómica: Ciclos Económicos, Crecimiento e Inflación*. Santiago, Chile: 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), August, pp.: 125-46.

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

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

Taylor, J. (1999); *Monetary Policy Rules*, Chicago and London: University of Chicago Press.

Taylor, J. (2000); "Low inflation, pass-through, and the pricing power of firms", *European Economic Review*, 44 (7), June, pp.: 1389-1408.

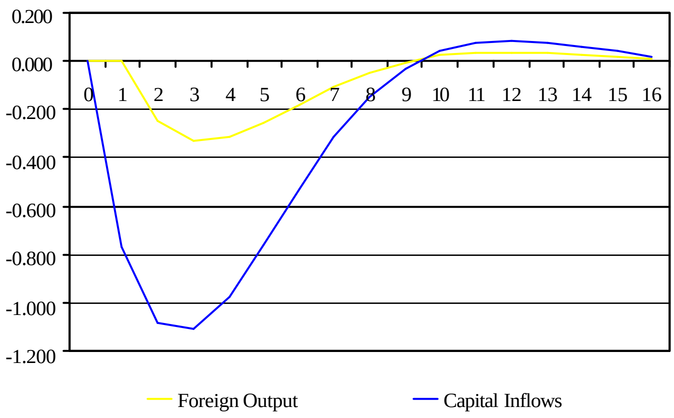
Valdés, R. (1998); "Efectos de la Política Monetaria en Chile", *Cuadernos de Economía*, 104, pp: 97-125.

Walsh, C. (2003); *Monetary Theory and Policy*, 2nd Edition, Cambridge, MA: MIT Press.

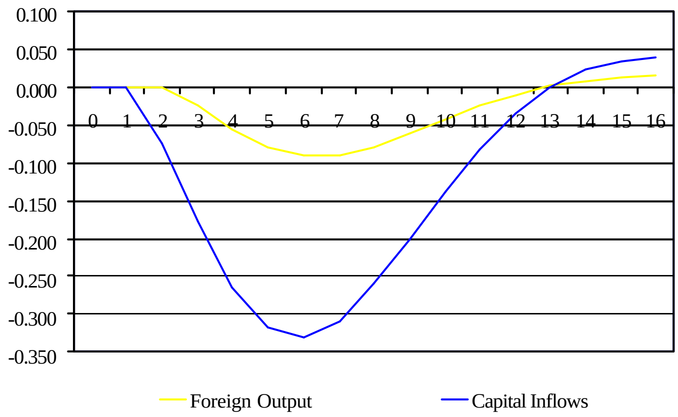
Woodford, M. (2003); *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton, NJ: Princeton University Press.

Figure 1: External Shocks: Capital Inflows and Foreign Output Gap (Deviations from respect to base scenario)

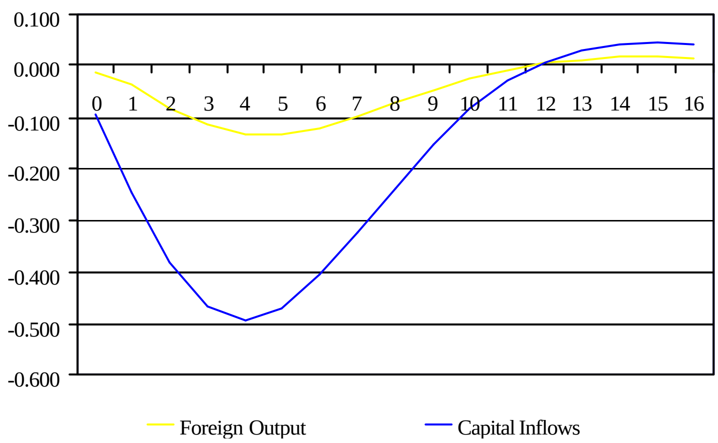
(a) Domestic Output Gap (% of Potential output)



(b) Inflation Rate (annual rate)



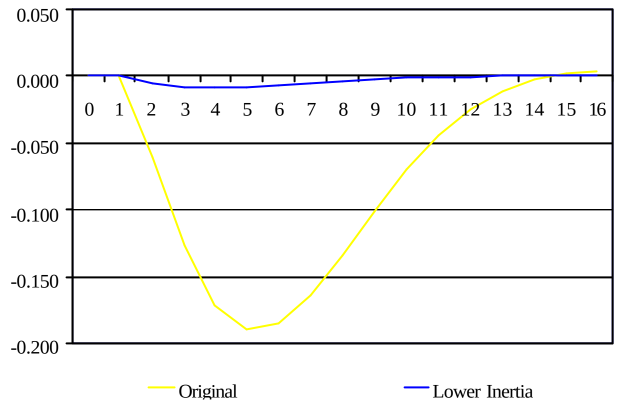
(c) Monetary Policy Rate (%, real rate)



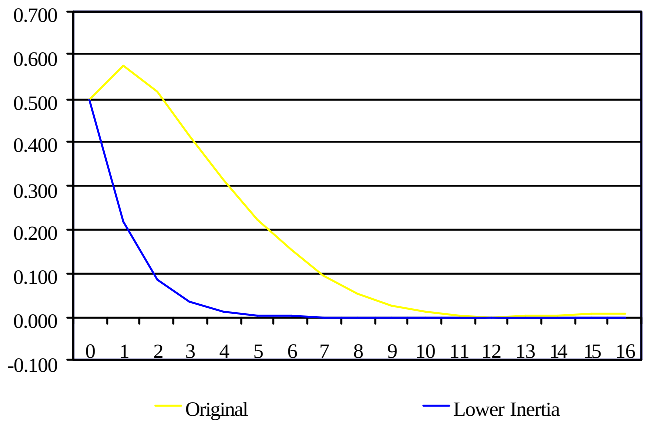
Source: Authors' own calculations. See the text for details.

Figure 2: Inflation Rate Shock
(Deviations from respect to base scenario)

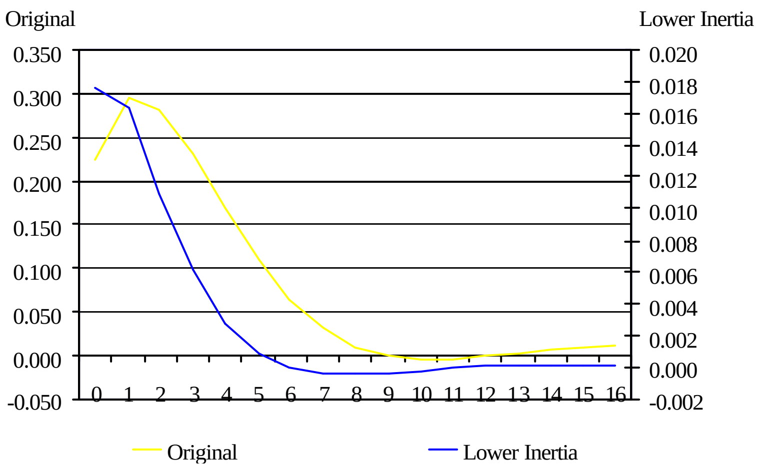
(a) Domestic Output Gap (% of Potential output)



(b) Inflation Rate (annual rate)



(c) Monetary Policy Rate (%, real rate)



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

Documentos de Trabajo Banco Central de Chile	**Working Papers Central Bank of Chile**
NÚMEROS ANTERIORES	PAST ISSUES

La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de $500 si es dentro de Chile y US$12 si es para fuera de Chile. Las solicitudes se pueden hacer por fax: (56-2) 6702231 o a través de correo electrónico: bcch@bcentral.cl.

Working Papers in PDF format can be downloaded free of charge from: www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for orders inside Chile the charge is Ch$500.) Orders can be placed by fax: (56-2) 6702231 or e-mail: bcch@bcentral.cl.

DTBC-242 Diciembre 2003
Tax Incentives for Retirement Savings: Macro and Welfare Effects in an OLG-GE Model with Liquidity Constraints and Heterogeneous Consumers
Rodrigo Cifuentes

DTBC-241 Diciembre 2003
A Toolkit for Analyzing Alternative Policies in the Chilean Economy
Rómulo Chumacero

DTBC-240 Diciembre 2003
Banking Industry and Monetary Policy: An Overview
J. Rodrigo Fuentes y Luis Antonio Ahumada

DTBC-239 Diciembre 2003
Tratado de Libre Comercio entre Chile y Estados Unidos: Revisión de Estudios que Cuantifican su Impacto
Mabel Cabezas

DTBC-238 Noviembre 2003
Chile's Regional Arrangements: The Importance of Market Access and Lowering the Tariff to Six Percent
Glenn W. Harrison, Thomas F. Rutherford y David G. Tarr

DTBC-237 Noviembre 2003
The Role of Credibility in the Cyclical Properties of Macroeconomic Policies in Emerging Economies
César Calderón, Roberto Duncan y Klaus Schmidt-Hebbel

DTBC-236 Noviembre 2003
Commodity Currencies and the Real Exchange Rate
Paul Cashin, Luis Felipe Céspedes y Ratna Sahay

DTBC-235 Octubre 2003
Heterogeneidad de la Transmisión Monetaria:
Efectos Sectoriales y Regionales
Héctor F. Bravo, Carlos J. García, Verónica Mies y Matías Tapia

DTBC-234 Octubre 2003
Must Original Sin Cause Macroeconomic Damnation?
Luis Felipe Céspedes, Roberto Chang y Andrés Velasco

DTBC-233 Octubre 2003
Stock de Capital de la Economía Chilena y su
Distribución Sectorial
Josué Pérez Toledo

DTBC-232 Octubre 2003
Pricing Policies and Inflation Inertia
Luis Céspedes, Michael Kumhof y Eric Parrado

DTBC-231 Octubre 2003
Banking Concentration: Implications for Systemic Risk
and Safety Net Design
Rodrigo Cifuentes

DTBC-230 Octubre 2003
The Effect of Cross-Industry Ownership on Pricing:
Evidence from Bank-Pension Fund Common Ownership in Chile
Luis Antonio Ahumada y Nicola Cetorelli

DTBC-229 Octubre 2003
Foreign Bank Entry and Business Volatility: Evidence from
U.S. States and Other Countries
Donald P. Morgan y Philip E. Strahan

DTBC-228 Octubre 2003
Financial Markets and Financial Leverage in a
Two-Country World-Economy
Simon Gilchrist

DTBC-227 Octubre 2003
Deposit Insurance: Handle with Care
Asli Demirgüç-Kunt y Edward J. Kane