Optimal Monetary Policy in an Open Economy DSGE Model *

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EXTENDED ABSTRACT

The inflation targeting process relies heavily on the use of macroeconomic models. In those models the central bank behavior is usually described by a simple policy instrument, the so called Taylor-type rule. In its simpler version the rule is such that the policy instrument (the interest rate) responds only to inflation and to the output gap. As noted by Svensson (2003) much research during the last two decades has examined simple instrument rules (mostly variants of the Taylor-type one). This research has contributed many important insights. For instance, the long-run response of the interest rate to inflation should be larger than one (Taylor principle) in order to ensure the determinacy of inflation and the uniqueness of equilibrium in sticky price models (Taylor 1999 and Woodford 2001). On the other hand, one line of research has concluded that Taylor-type rules are robust to the uncertainty about which model is the best representation of reality (Levin *et al* 1999).

Although Taylor-type rules are tractable, easy to introduce in macro models and robust, they have important limitations. In particular, as noted by Svensson 1997 the response coefficients in an optimal reaction function depend on the weights that the central bank assigns to different target variables in the loss criterion and on structural parameters of the model. In this sense, the Taylor rule coefficients are reduced form ones and they lack a structural interpretation. Deducing from them the central bank preferences, and the structural parameters of the

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economy, is in general not possible. To overcome these limitations, Svensson (2003) suggests a convenient, more structural representation of monetary policy: a *targeting rule* . A general *targeting rule* is a high level specification of a monetary policy rule that specifies *operational objectives*, that is the target variables, *the targets* and the *loss function* to be minimized. As noted by Svensson (2005) an optimal targeting rule is invariant to everything else in the model, including additive judgment and the stochastic properties of additive shocks. Thus, it is a compact, robust, and structural representation of monetary policy, and much more robust than the optimal reaction function. A simple *targeting rule* can potentially be a practical representation of robust monetary policy, a robust monetary policy that performs reasonably well under different circumstances.

In this context, the objective of this paper is to implement the *targeting rule* approach in the structural model that describes the Chilean economy. This is a medium-sized DSGE model, the Model of Analysis and Simulation (MAS), described in Medina and Soto 2007. Implementing this targeting rule involves two key steps. The first one is to implement an optimal monetary policy under commitment. The second one is to use this optimal policy to perform *optimal policy projections* (OPP). This line of research has already been implemented in practice. In particular, Adolfson et al (2008) have constructed OPP in RAMSES, the structural model of the Swedish Central Bank.

Our main results are that a flexible loss criterion in which the central bank penalizes inflation deviation from target as well as output and interest rate volatility accords to dynamic of the Chilean economy in the last twenty years. On the other hand, we show that in the face of persistent supply shocks, like an increase in the price of oil, strict CPI inflation targeting induces high volatility in output, interest rate and real exchange rate. On the contrary, strict Core CPI targeting is capable of accelerating the CPI inflation convergence to its target level; bringing inflation down in the relevant policy horizon. This is achived with relatively small costs in output, interest rate and real exchange rate volatility.

In what follow, we will briefly describe the methodology used as well as some more detailed preliminary results. We will conclude by pointing out the issues that are going to be address in a later stage.

The MAS is a DSGE model describing the Chilean economy. It can be cast in the following way:

$$(1.1)\ X_{t+1} = AA_{11}X_t + AA_{12}x_t + B_1 i_t + C\varepsilon_{t+1}$$

$$(1.2)\ Hx_{t+1} = AA_{21}X_t + AA_{22}x_t + B_2 i_t$$

where X_t represents predetermined variables, x_t,are forward-looking variables and ε_{t+1} are exogenous shock. The policy instrument is given by i_t and the model can be solved either by specifying a Taylor-type rule for the interest rate (the standard approach) or specifying a loss criterion of the following form:

$$(1.3)\ L_t = \frac{1}{2}\begin{bmatrix} X_t \\ x_t \\ i_t \end{bmatrix}' W \begin{bmatrix} X_t \\ x_t \\ i_t \end{bmatrix}$$

where the W matrix contains the weights given by the central bank to th variance and covariance of all variables. The optimization process involves minimizing (1.3) subject to (1.1)-(1.2) equations. In practice, this process involves introducing $nX+nx+1$ first order conditions to the $nX+nx$ system equations in (1.1)-(1.2). Hence the model considering the first order conditions can be re-expressed as:

$$(2)\ \begin{bmatrix} \bar{H} & 0 \\ 0 & A' \end{bmatrix} \begin{bmatrix} X_{t+1} \\ x_{t+1/t} \\ i_{t+1/t} \\ \hline \xi_{t+1/t} \\ \Xi_t \end{bmatrix} = \begin{bmatrix} \bar{A} & 0 \\ W & \frac{1}{\delta}\bar{H}' \end{bmatrix} \begin{bmatrix} X_t \\ x_t \\ i_t \\ \hline \xi_t \\ \Xi_{t-1} \end{bmatrix} + \begin{bmatrix} C \\ 0 \\ 0 \\ \hline 0 \\ 0 \end{bmatrix} \varepsilon_{t+1}$$

where $\xi_{t+1/t}$ and Ξ_t represent the Lagrange multipliers associated to the predetermined and forward-looking variables respectively. The model in (2) can is solved using the Uhlig (1995) approach. In practice the solution can be written as a function of the predetermined variables and the shocks:

$$\begin{bmatrix} x_t \\ i_t \end{bmatrix} = \begin{bmatrix} F_x \\ F_i \end{bmatrix} \begin{bmatrix} X_t \\ \Xi_{t-1} \end{bmatrix},$$

$$\begin{bmatrix} X_{t+1} \\ \Xi_t \end{bmatrix} = \begin{bmatrix} F_x \\ F_i \end{bmatrix} \begin{bmatrix} X_t \\ \Xi_{t-1} \end{bmatrix} + \begin{bmatrix} C \\ 0 \end{bmatrix} \varepsilon_{t+1.}$$

where the policy function F_i depends on the structure of the economy and the W matrix.

We implement this optimal policy approach in the MAS model. This involves expanding the model from 92 variables to 183. We consider two alternative loss functions:

$$L_t = (\pi_t - \pi)^2 \quad Strict \quad Inflation$$

and

$$L_t = (\pi_t - \pi)^2 + 1.0(y_t - y)^2 + 0.4(i_t - i)^2 \qquad Flexible \quad Loss$$

To illustrate the implications of the two alternative criterions, we analyse the responses of different variables to an oil price shock and to a copper price shock. In the first case we assume the price of oil increases over one year to 40% an remains in that level in the future (permanent shock to the level). As shown in figure 1, under the flexible loss criterion, inflation (CPI and core) increases importantly and it is above target even after two years, which is the relevant horizon considered by the Chilean Central Bank. Now, when a strict core inflation loss criterion is set in place, CPI inflation is still positive in the first two years but it converges to the target after two years. In this case output contracts by more, given a higher interest rate. On the other hand, the real exchange rate (RER) appreciates up to 1% in a very persistent way.

Now, if the central bank stabilizes CPI inflation completely (strict CPI loss criterion), it requires core CPI inflation to fall below target for more than two years. The costs of inducing this deflation are given by an important increase in the policy rate that generates a contraction in the GDP and a larger RER appreciation. Hence, to completely stabilize CPI inflation is much more costly than stabilizing core inflation. On the other hand, stabilizing core inflation induces a faster convergence of CPI inflation to the target without generating an excessive output contraction or RER appreciation.

In this paper we also study the implications of alternative loss criteria for different shocks. This enables us to understand the policy trade-off faced by the central bank and to quantify the costs of adopting a given loss criterion. This cost depends on both the size and persistence of the shock as well as the specific criterion being in place.

The next step in this paper is to implement optima policy projections. In doing so, we will first determine (either by calibration or estimation) the loss weights that have been in place in Chile since the inflation targeting period. Then we will discuss the way in which the optimization problem has to be set when real data are considered. In particular, and following Adolfson *et al* (2008) we will implement an optimal policy rule in a timeless perspective. Finally, we will compare the welfare loss criterion introduced to the one that will prevail if each of the frictions present in the model is removed. In this way we will be able to assess the costs of those frictions.

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Figure 1. Responses to an Oil Price shock under Alternative Loss Functions

(percentage deviations from the steady state)