# Monetary Policy in Small Open Economies: The Chilean Experience

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**Abstract**

Since 1990, Chile has adopted, explicitly, an inflation targeting monetary policy. In small open economies, however, the Central Bank may have additional objectives; avoiding excessive fluctuations in the exchange rate and/or output that are not always explicit. In this paper we report estimates of the Chilean Central Bank reaction function. Following Clarida, Gali and Gertler (1998), we find evidence that the Chilean Central Bank has been forward looking: it responds to anticipated inflation deviations from target. In this context, we find that the Chilean Central Bank has some other implicit objectives; avoiding output and exchange rate fluctuations above those consistent with inflation targeting. Finally, the Central Bank's reactions to real exchange rate deviations are non-linear; it reacts strongly to large deviations rather than to small ones.

JEL: E52; E58; C22.

Keywords: Central Bank's reaction function, Inflation targeting, GMM estimation and Structural times series models.

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# 1 Introduction

Since 1990, Chile has adopted an explicit inflation targeting monetary policy. In practice, this means that every year the Central Bank (CB) announces the inflation target that is supposed to be consistent with full employment, and then it makes use of the monetary instruments (interest rate) to fulfill this objective. Some other objectives, like controlling the real exchange rate or avoiding excessive fluctuations in the output level are not explicit objectives of the Chilean CB.

There is some evidence, however, that Central Banks in emerging economies use the interest rate to avoid exchange rate fluctuations. In fact, Calvo and Reinhart (2000), concluded that in some countries interest rate and exchange rate move in the same direction; that is, depreciations in the exchange rate (an increase in the domestic price of foreign currency) generate an increase in the interest rate controlled by the CB. Furthermore, they argue that interest rate policy is replacing foreign exchange intervention as the preferred means of smoothing exchange rate. According to this view monetary authorities try to stabilize the exchange rate, even if they claim to have a flexible exchange rate system. The reason? ; "fear of floating".

Another reason why a CB may react to real exchange rate fluctuations (independently of its impact on future inflation) is that in this way it can improve macroeconomic performance. In fact, some simulations, reported by Cecchetti et all (2000), suggested that responding to exchange rate shocks *over and above* the effect of such a shock on the central bank's inflation forecast appears to be *welfare-improving*[1]. In a different study, Batini et all (2001), concluded that an inflation-forecast-based rule , i.e., one that reacts to deviations of expected inflation from target, performs well in a two-sector model calibrated on UK data. Adding a separate response to the level of the real exchange rate (contemporaneous and lagged) appears to reduce the difference in adjustment between output gaps in the two sectors of the economy, but the improvement is only marginal.

The objective of this paper is to assess the importance of exchange rate and output fluctuations in the conduct of monetary policy in Chile. In doing so, we estimate the monetary policy reaction function of the Chilean CB using monthly data from 1985.01 to 2001.10. We adopt this period because since 1985 the CB has been using the interest rate as its main policy instrument. We also present

[1] The simulations reported in Cecchetti et all are based on the Batini and Nelson model for the UK (Batini and Nelson, 2000).

estimations for the sub-sample 1985.01 to 1990.08 where the CB did not have any explicit target, and for the sub-sample 1990.09 to 2001.10 where inflation was the only explicitly-stated objective of monetary policy. Contrasting results from both periods allows us to compare the reaction functions under the two regimes.

The theoretical specification we use allows us to test whether inflation targeting played an important role in the determination of the CB interest rate. In this framework, suggested by Clarida, Gali and Gertler (1998) and Clarida (2000), we can also evaluate the importance of some "non-explicit" objectives that the CB may have, namely controlling exchange rate fluctuations or avoiding deviations of output from its potential level.

In previous studies for Chile, Parrado (2000) and Parrado and Velasco (2001), the basic finding is that neither the nominal exchange rate nor output deviations play a significant role in determining the monetary policy in Chile. Those were the first attempts to identify, in a framework different than the VAR, the Chilean CB monetary policy reaction function. Although, we adopt a similar approach (GMM estimation procedure) to identify the systematic components of the monetary policy in Chile, the questions we address, and to some extent the methodology itself, differ substantially from Parrado (2000) and Parrado and Velasco (2001) seminal papers.

Besides characterizing the CB reaction function, we test for nonlinear responses to real exchange rate deviations; that is we test whether relatively large deviations generate a higher policy response. On the other hand, we assess the importance that future paths of inflation have in the monetary policy design.

The basic results we find are as follows:

i) As expected, in the targeting period, from 1990.09 to 2001.10, the Chilean CB reacted to anticipated inflation. The CB also reacted to output and exchange rate fluctuations above the predicted inflation effects. Then, we conclude that in this period there were additional non-explicit objectives of the monetary authority. This result was robust to different specifications of the monetary policy reaction function.

ii) In the pre-explicit inflation targeting period, from 1985.01 to 1990.08, the CB reacted to exchange rate and output fluctuations. The response to anticipated inflation was, in most cases, not significant. We can therefore characterize this period as having a monetary policy that was accommodative with respect to inflation.

This paper is organized as follows; in Section 2 we briefly describe the main objectives of the Chilean Central Bank and the instrument it has been using since 1985. In Section 3, we specify a simple forward-looking model of policy interest rate. This is a modified version of Clarida, Gali and Gertler (1998 and 2000) model. In particular, we introduced modifications to estimate a rule that is based on managing the real (*ex-post*) interest rate as opposed to the nominal interest rate. This modification is of crucial importance, given the way in which the monetary policy is formulated in Chile.

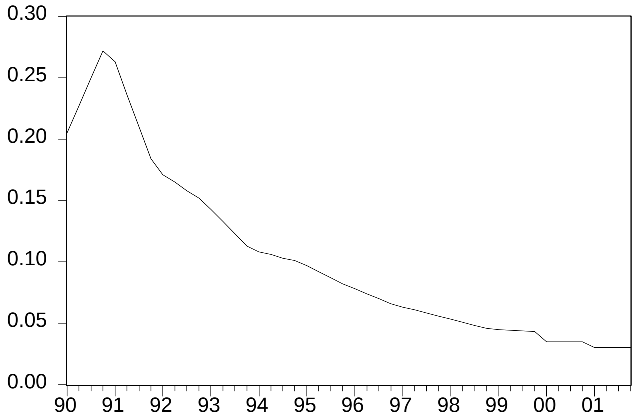
In section 4, we describe the estimation procedure and the data that are used in this study. In Section 5, we present the basic results from estimating by GMM the monetary policy reaction function. Finally, we present the conclusions in Section 6.

## 2 Monetary and exchange rate policies in Chile

The 1980 Chilean Constitution empowers the CB to "stabilize the value of the currency and provide normality in the functioning of internal and external payments". This statement has been interpreted as giving three main objectives to the CB: to control inflation, to provide a sound regulation of the banking system, and to avoid situations that may lead to currency crisis.

From 1980 to 1990, the CB did not have any explicit target for inflation. It is only from 1990 that the CB has adopted an explicit inflation targeting regime. The procedure works as follows: each September, in its Report to the Congress, the CB announces a CPI inflation target for the next year (December year-on-year CPI inflation). The target was gradually adjusted so as to allow for a gradual reduction of inflation. For example, in 1990 the target was set at 27% whereas in 2001 the target was 3% (Figure 1).

Figure 1: Chile. CPI Inflation Target




As noted by Parrado (2001), the inflation targeting regime allows for flexibility; there is no legal mandate to achieve the target each year. This flexibility along with the gradual adjustment of the inflation target, have contributed to maintain high rates of real GDP growth over the past decade; on average 6.7% a year between 1990 and 2000.

Since 1985, the interest rate has been the main instrument of monetary policy. From 1985 to April 1995, the CB used a short-term (three months) interest rate indexed to CPI inflation. In May 1995 the CB changed its policy instrument to an overnight indexed interest rate which is controlled through open-market operations. Those operations are performed by issuing CB papers and by conducting repos and anti-repos.

As pointed out by Valdes (1998), the use of indexed interest rates is equivalent to set *ex − post* real interest rates[2]. There are three basic reasons of why real interest rates have been in use since 1985. First, the demand for money has been unstable over the period, therefore the use of interest rate as policy instrument has more predictable effects over output and inflation than monetary aggregates. Second, the high degree of indexation of the Chilean economy (including financial contracts) makes it difficult to use nominal interest rates. Finally, in an environment of high and unpredictable inflation, movements in the real interest rates are easy to understand and do not have double interpretations as in the case of nominal rates.

The Chilean CB has also the power to set the framework of exchange rate policy. From August 1984 to September 1999, the CB adopted a crawling exchange rate band, which was subject to several modifications (see Figure 2). Since September 2, 1999, the country has embraced a fully-flexible exchange rate regime, with the possibility of monetary authority intervening in the market only if the exchange rate does not reflect the "real" value of the foreign currency (Parrado 2001, pp.7).

Figure 2: Nominal Exch. Rate (Pesos/US$)


The basic instruments the CB used to stabilized the nominal exchange rate within the band were interventions in the foreign exchange market and, in some cases, modifications to the limits of the

[2]Given a more stable path for inflation, the Chilean CB has abandoned, in August 2001, the use of real interest rates as policy instrument.

band. As noted by Parrado (2001), at the end of 1991, Chile's strong external accounts forced the CB to lower the referential dollar exchange rate (central parity) by 5 percent and to widen the band to ± 10 percent. Although this decision was taken to increase the market role in determining the exchange rate, in March of 1992 it was decided that the CB should have a "dirty" floating option to intervene within the band. In this context, intra-marginal foreign-exchange rate interventions by the CB were frequent and, at times, intense (Landerretche et all, 1999).

In addition to the previous instruments, the CB has also issued (since 1998) financial instruments indexed to US dollars, the so called *Pagares Reajustables en Dolares (PRD)*. In this way, economic agents may cover themselves against exchange rate fluctuations without generating distress in the spot exchange rate market.

In summary, the CB has specific instruments for each target. In this context, it is assumed that interest rate is used as the inflation targeting instrument and not as an instrument to control exchange rate fluctuations. Of course, this hypothesis can be tested.

# 3 A forward-looking model of interest rate

Following Clarida, Gali and Gertler (1998 and 2000) we specify a forward-looking model for the nominal interest rate. We introduce, however, some modifications in order to obtain the *ex-post* real interest rate that is, in practice, the instrument used by the Chilean CB since 1985.

In a forward-looking environment, the nominal policy interest rate will be determined by current expectations of CB's objectives. If we assume the CB is concerned about deviations of future inflation, output and exchange rate, we can express the reaction function as follows;

$$i_t^* = \bar{i} + \beta \left( E_t \left[ \pi_{t+n} \right] - \pi_{t+n}^* \right) + \gamma_1 \left( E_t \left[ y_t \right] - y_t^* \right) + \gamma_2 \left( E_t \left[ e_t \right] - e_t^* \right) \tag{1}$$

where $i_t^*$ is the nominal interest rate set by the CB and $\left( E_t \left[ \pi_{t+n} \right] - \pi_{t+n}^* \right)$ is the deviation of expected inflation from a predetermined target $\pi_{t+n}^*$[3]. The CB may also be concerned about deviations

[3] In general the inflation target is assumed to be a fixed number. We adopt a more general approach that enables us to consider the case in which the target is changing over time. This case is of particular importance in economies were inflation is a non-stationary process, and were targets are converging gradually to the long run inflation level.

of output from the equilibrium level, $E_t[y_t] - y_t^*$, and deviations of the real exchange rate, $E_t[e_t] - e_t^*$. It is important to notice that the parameters $\gamma_1$ and $\gamma_2$ capture the non-inflationary components of output and exchange rate deviations. That is, both elements may be objectives of monetary policy even when expected inflation is on target $\left(\left(E_t[\pi_{t+n}] - \pi_{t+n}^*\right) = 0\right)$. Therefore, the specification in (1) allows us to test whether output and exchange rate are *per se* objectives of the CB. In fact, under the null hypothesis that the CB does not care about output and exchange rate deviations *per se*, the coefficients $\gamma_1$ and $\gamma_2$ are equal to zero.

We can re-express equation (1) in real terms by substracting $E_t[\pi_{t+n}]$ from both sides of (1), and by adding and substracting $\pi_{t+n}^*$ from the right hand side of (1). The *ex-ante* real interest rate is expressed as follows;

$$r_{ea,t}^* = \overline{r} + (\beta - 1)\left(E_t[\pi_{t+n}] - \pi_{t+n}^*\right) + \gamma_1\left(E_t[y_t] - y_t^*\right) + \gamma_2\left(E_t[e_t] - e_t^*\right) \tag{2}$$

Where $r_{ea,t}^* = i_t^* - E_t[\pi_{t+n}]$ is the *ex-ante* real interest rate and $\overline{r}$ is the equilibrium *ex-ante* real interest rate. As we can see, if $\beta$ is greater than one, the real interest rate increases whenever expected inflation is above the target level. In this case, the CB tries to stabilize inflation.

On the contrary, when $\beta$ is less than one the CB moves the interest rate in order to partially accommodate an increase in the expected level of inflation. In this case, the CB is not stabilizing inflation.

Now, in order to obtain an expression for the *ex-post* real interest rate, we add and substract the actual inflation over $t+n$ on the left hand side of (2). Then, the *ex-post* real interest rate is defined as follows;

$$r_t^* = \overline{r} + (\beta - 1)\left(E_t[\pi_{t+n}] - \pi_{t+n}^*\right) + \gamma_1\left(E_t[y_t] - y_t^*\right) + \gamma_2\left(E_t[e_t] - e_t^*\right) + \varepsilon_t \tag{3}$$

where $r_t^* = i_t^* - \pi_{t+n}$ is the *ex-post* real interest rate and $\varepsilon_t = E_t[\pi_{t+n}] - \pi_{t+n}$ is the inflation prediction error. Equation (3), however, does not capture the tendency that a CB may have to smooth changes in interest rates (see Clarida et all 1998). Introducing this tendency may be a difficult task so it is assumed, for simplicity, that the *ex-post* real interest rate, $r_t$, partially adjust to its target level, $r_t^*$. This assumption can be expressed as:

$$r_t = (1-\rho)r_t^* + \rho r_{t-1} + v_t \tag{4}$$

where the parameter $\rho \epsilon [0,1]$ captures the degree of interest rate smoothing and $v_t$ represents a zero mean real interest rate shock.

By combining (3) and (4), we obtain and expression for the real interest rate that allows for inertial behavior;

$$r_t = (1-\rho)\overline{r} + (1-\rho)\left[(\beta-1)\left(\pi_{t+n} - \pi_{t+n}^*\right) + \gamma_1\left(y_t - y_t^*\right) + \gamma_2\left(e_t - e_t^*\right)\right] + \rho r_{t-1} + u_t \tag{5}$$

equation (5) is expressed now as function of actual realizations of the variables in the future (in this case only inflation) plus an error term that is a linear combination of prediction errors of the relevant explanatory variables. This term, $u_t$, is defined as:

$$u_t = \{v_t + (1-\rho)\left[\beta\left(E_t\left[\pi_{t+n}\right] - \pi_{t+n}\right) + \gamma_1\left(E_t\left[y_t\right] - y_t\right) + \gamma_2\left(E_t\left[e_t\right] - e_t\right)\right]\}$$

Equation (5) is the expression we are going to estimate empirically. One advantage of this formulation is that all the dependent variables are future and current realizations of observable variables. Therefore we avoid the problem of modelling, explicitly, agent's expectations.

## 4 Estimation

Equation (5) contains all the parameters we are interested in. However, it is evident that the correlation between the error term, $u_t$, an future inflation is different from zero. In this circumstances OLS estimation will not be a sensible method to obtain unbiased estimators. We use, instead, a GMM approach, to obtain unbiased and consistent estimators.

The GMM approach requires us to impose an orthogonality condition between the explanatory variables and the error term in (5). In particular, let $Z_t$ be the set of instruments orthogonal to $u_t$, that is $E\left[Z_t u_t\right] = 0$. This set of instruments are known when the CB sets the real interest rate, $r_t$. Then,we can estimate the following expression using the GMM approach:

$$E_t\left\{\left(r_t-(1-\rho)\bar{r}-(1-\rho)\left[(\beta-1)\left(\pi_{t+n}-\pi_{t+n}^*\right)+\gamma_1\left(y_t-y_t^*\right)+\gamma_2\left(e_t-e_t^*\right)\right]\right)Z_t\right\}=0$$

By construction, the residual series $u_t$ features and $MA(n-1)$ structure and empirical moments cannot be considered as serially independent. In order to sort out this problem we follow the estimation procedure suggested by Favero (2001); when implementing GMM estimation we correct for heteroscedasticity and autocorrelation of unknown form with a lag truncation parameter of $n-1$. Furthermore, Barlett weights are chosen to ensure positive definiteness of the estimated variance-covariance matrix (Favero 2001, pp.233).

In order to assess whether a particular set of instruments, $Z_t$, is valid or not a $J-$ test of overidentifying restrictions is used. This test has a $\chi^2$ distribution with $m-k$ degrees of freedom, where $m$ is the number of instruments used and $k$ is the number of variables to be instrumented.

## 4.1 Data

The estimates we present use monthly time series from 1985.01 to 2001.10. The data used are the following;

$y$: log IMACEC[4] (Source: Central Bank of Chile).

$\pi_t$: Year on year CPI variation (Source: Central Bank of Chile).

$\pi_t^*$: Inflation target. From 1990 to 2001 Chilean CB data. From 1987 to 1990 private expectations (Valdes 1998).

$e_t$: log of the real exchange rate (Source: Central Bank of Chile).

$r_t$: CB's domestic real interest rate. This is an hybrid definition; from 1987 to 1995 is the indexed interest rate on the three months CB instruments (PRBC 90), from 1995 to 2001 is the CB's overnight indexed interest rate (Source: Central Bank of Chile).

$tot$: Terms of trade. This variable is used as one of the instruments. (Source: Valdes and Bennett (2001))

[4]The IMACEC is a monthly inicator of economic activity, which covers over 90% of Chilean GDP.

### 4.1.1 Identifying cyclical component in the series

The long run equilibrium of the relevant variables, output and exchange rate, can be obtained by applying different filtering procedures. For instance, Parrado (2000) in a similar exercise for Chile used a quadratic detrending procedure to obtain the output gap, $(y_t - y_t^*)$. Alternatively, a Hodrick and Prescott (HP) filter can used.

In this paper a different approach is used; in order to determine the long run values of output and exchange rate a structural times series model for each series is fitted. Using this approach has the advantage of avoiding the creation of spurious cycles, that can be one of the consequences of using a Hodrick and Prescott ad-hoc filtering procedure (Harvey and Jaeger 1993). Another advantage of this procedure is that the irregular movements of the series can be separated from the cycle.

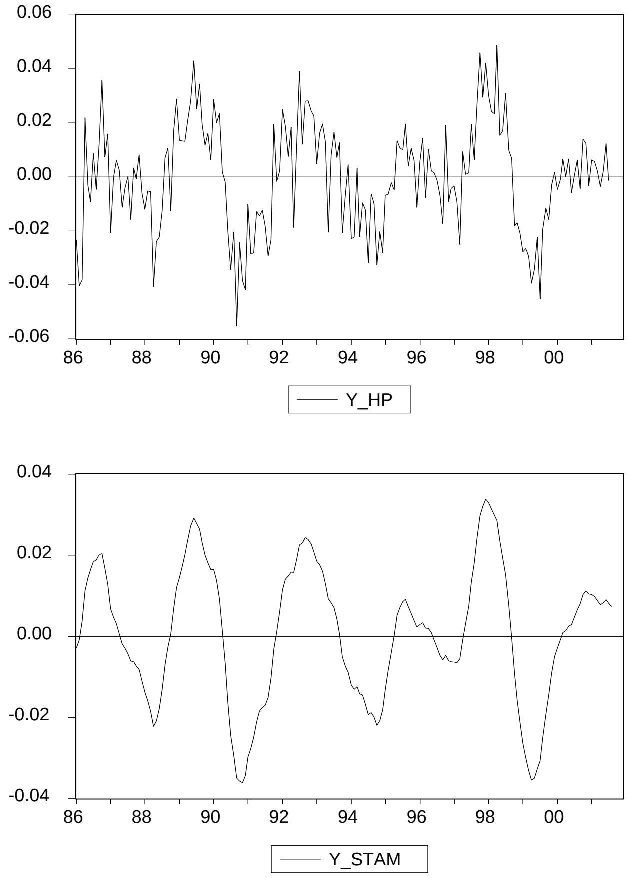
Fitting a trend plus cycle model to the Chilean output[5], $y_t$ , results in an output gap series that is less volatile than the series obtained with the Hodrick-Prescott filter (see Figure3). In a similar way, the output gap obtained by using linear and quadratic detrending procedures is much more noisier. The cyclical component obtained from HP filtering and alternative detrending procedures is much more volatile because it includes the irregular movements in output which appear to be substantial.

From an economic perspective, the cycle obtained with a trend plus cycle model has a meaningful interpretation. In fact, it captures many of the stylized facts of the Chilean business cycle. In particular, the slowdown of the Chilean economy at the beginning of the 90s and the subsequent recovery, between 1992 to 1994, are well reflected by this cycle. On the other hand, the rapid expansion of the economy between 1997 and mid 1998 and the subsequent crisis in 1999 are also captured. Finally, the slow recovery of the economy in 2000 and 2001 is reflected at the end of the period.

To obtain the cyclical component of the real exchange rate (RER), $e_t$, the same procedure as before is applied; a structural time series model is fitted. In this case, the cycle obtained by fitting a structural model is less volatile than a cycle obtained using the HP filter. Another important difference is that the HP filters seems to present some seasonal behavior (appreciations at the beginning of each year) that may reflect changes in seasonality (see Figure 4). As pointed out by Harvey (2001) changes in seasonality may not be captured by the non-model-based seasonal adjustment procedure such as the U.S. Census Bureau's X-12 used when filtering by HP.

[5] The models have been estimated using STAMP 6.0 software.

Figure 3: Chilean output gap




The economic interpretation of RER deviations is more difficult. In fact, there is no consensus in Chile about the level of the equilibrium RER in the past decade. Many economists suggested that an important degree of real appreciation was present in the 90s, but there is no a clear description of this appreciation path on a monthly basis.

Finally, for inflation we do not need to use any detrending procedure, instead we compute the inflation gap, $\pi_{t+n} - \pi^*_{t+n}$, as the difference between actual inflation and target inflation. The series is presented in Figure 5

Figure 4: Chile RER cyclical deviations

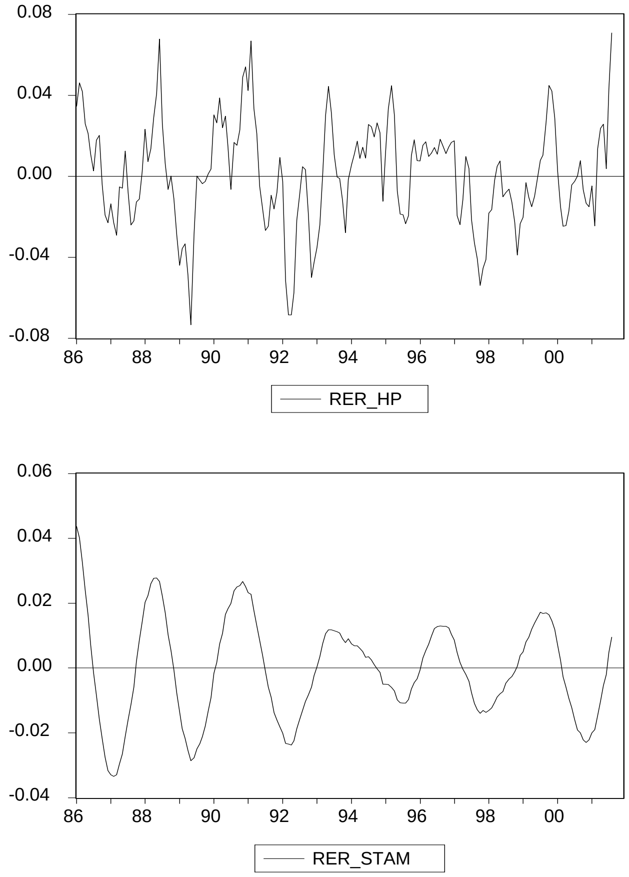
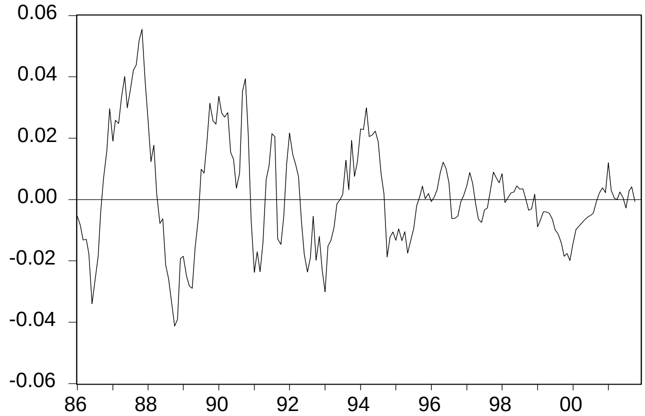



Figure 5: Chile: Inflation gap



# 5 Results

In this section, we present the results of estimating the policy reaction function in (5) and two alternative specifications. We assume $n$=15, which is consistent with the way in which the Chilean CB sets its inflation targets. On the other hand, and according to the lag in the availability of information, we assume that the CB observes output in $t-1$ (one-month observation lag).

The set of instruments, $Z_t$, included six lags in output gap, three lags in policy interest rate, lags in the inflation gap and terms of trade variation. In all the cases the $J$-test cannot reject the validity of this set of instruments.

## 5.1 Linear policy response to exchange rate

In table 1, we present the result of estimating by GMM the monetary policy rule in (5). The implicit assumption in this formulation is that policy response to real exchange rate deviations is linear. This assumption will be removed later on.

The results for the full sample, 1985.01 to 2000.10, indicate that the CB is following a forward-looking approach to set the interest rate, however, this effect is not statistically significant. On the other hand, even if the output level has not been an explicit objective of the CB in this period, deviations of this variable from its long run equilibrium generate a monetary policy response. There is also a response of the CB to real exchange rate deviations.

For the period without an explicit inflation targeting, 1985.01 to 1990.08, we find a negative, but not significant response to expected inflation. In this period, the CB's response to exchange rate and output deviations was positive and significant. We characterize the monetary policy in this period as an accommodative one with respect to inflation, but a policy that tried to stabilize output and the exchange rate.

As expected, the results for the targeting period, 1990.09 to 2001.01, show a positive and significant response to expected inflation. This is consistent with the widespread view that, since 1990, the Chilean CB has responded strongly to inflation. What is not always recognized, is that the CB was, at the same time, concerned about deviations of output and the real exchange, above the effects predicted for inflation. The smoothness parameter, $\rho$ seems to be very high, however in a monthly basis this means that the mean lag of a monetary shock is less than one year[6]. For the US, Clarida et all (2000) find that the implied smoothness parameter is of the same magnitude but the mean lag is larger because the data are on a quarterly basis

**Table 1. Estimation of (5) by GMM**

| | $\bar{rr}$ | $\rho$ | $(\beta - 1)$ | $\gamma_1$ | $\gamma_2$ | $J - Test$ |
|---|---|---|---|---|---|---|
| Full Sample | 0.067 | 0.958 | 0.576 | 1.776 | 0.574 | 7.8 |
| (1987.01-2001.10) | (0.00) | (0.00) | (0.25) | (0.40) | (0.31) | [0.02] |
| Non Targeting Period | 0.064 | 0.920 | −0.081 | 2.303 | 1.910 | 3.0 |
| (1987.01-1990.08) | (0.00) | (0.01) | (0.06) | (0.15) | (0.10) | [0.01] |
| Targeting Period | 0.054 | 0.867 | 0.744 | 0.549 | 0.346 | 7.0 |
| (1990.09-2001.10) | (0.00) | (0.03) | (0.14) | (0.27) | (0.15) | [0.01] |

$J - Test$ is the test for overidentifying restrictions that has a distribution $\chi^2_{19}$.

Standard Errors in parentheses ()

$p$-values in brackets []

### 5.1.1 Response to long-term inflation deviations

The formulation in (5) can be modified to allow for responses not only to a specific target in time, but to a path of future inflation gaps. As suggested by Wadhwani (2000), in the short-run, policymakers may react to exchange rate fluctuations to stabilize future path of inflations. In fact, if exchange rate misalignment can affect the future path of inflation (relative to the horizon that is considered in the design of monetary policy), then it maybe the case that policymakers will react to exchange rate fluctuations, even if those fluctuations do not have any impact on short-run inflation (or, in this case, inflation in $t + 15$).

A way in which we can test the above hypothesis is by re-expressing equation (5) as;

[6] The mean lag of a monetary shock, in months, is defined as $\frac{1}{1-\rho}$.

$$r_t = (1-\rho)\bar{r} + (1-\rho)\left[(\beta-1)\sum_{n=15}^{24}\frac{\left(\pi_{t+n}-\pi^*_{t+n}\right)}{9} + \gamma_1\left(y_t - y^*_t\right) + \gamma_2\left(e_t - e^*_t\right)\right] + \rho r_{t-1} + u_t \quad (6)$$

Now, if the monetary authority wants to stabilize the future path of inflation gaps (from $n$=15 to 24 for instance), then $\beta > 1$ and $\gamma_1$ and $\gamma_2$ will capture the degree to which CB is concerned about output and exchange rate deviations that do not affect this path. In table 2 we present the results of estimating equation (6) for the two sub-samples.

**Table 2. Estimation of (6) by GMM**

| | $\bar{rr}$ | $\rho$ | $(\beta-1)$ | $\gamma_1$ | $\gamma_2$ | $J-Test$ |
|---|---|---|---|---|---|---|
| Non Targeting Period | 0.060 | 0.934 | 0.146 | 1.498 | 1.412 | 2.2 |
| (1987.01-1990.08) | (0.00) | (0.01) | (0.15) | (0.10) | (0.08) | [0.01] |
| Targeting Period | 0.069 | 0.791 | 0.380 | 1.076 | 1.157 | 4.8 |
| (1990.09-2001.10) | (0.00) | (0.02) | (0.10) | (0.11) | (0.11) | [0.01] |

$J-Test$ is the test for overidentifying restrictions that has a distribution $\chi^2_{19}$.

Standard Errors in parentheses ()

$p$-values in brackets []

As we can see, even in the case of longer horizons for the inflation gap, the Chilean CB is concerned about output and exchange rate deviations. This result is consistent for the two sub-samples and may indicate the presence of monetary policy objectives that are not explicit.

## 5.2 Nonlinear policy response to exchange rate

It has been argued (Calvo and Reinhart, 2000), that monetary policy can be determined by exchange rate considerations. In particular, developing economies may react to exchange rate misalignment because the abandonment of an exchange rate regime may cause important economic disruptions.

In Chile, the CB has an explicit objective for the nominal exchange rate but, as we discuss in Section 2, was not supposed to use the interest rate to fulfill this objective.

In practice, however, the CB may respond to real exchange rate fluctuations even if those fluctuations are consistent with the nominal exchange rate band. In fact, fluctuations in the exchange rate may signal a probability of devaluation. In this case, monetary authorities will try to avoid an exchange rate collapse by defending a "non-explicit" exchange rate target. This reaction corresponds to the "fear of floating" suggested by Calvo and Reinhart (2000).

In some ways, the results in table 1 and 2 confirm the fact that the Chilean CB wants to stabilize the exchange rate independently of its inflationary impacts. However, it is difficult to distinguish whether the CB is reacting just to large misalignment. If the CB reacts stronger to large deviations, there may be, a "fear of floating"; where larger fluctuations signal a high probability of collapse and the CB attempts to offset these expectations.

In order to test whether this response is linear we re-state equation (5). In particular, we allow for differentiated responses to different levels of misalignment. In doing so, we split real exchange rate deviations in those that are "small fluctuations" and those that are "large fluctuations"[7]. Equation (5), then can be expressed as follows;

$$rr_t = (1-\rho)\bar{rr} + (1-\rho)\left[(\beta-1)\left(\pi_{t+n} - \pi^*_{t+n}\right) + \gamma_1\left(y_t - y^*_t\right) + \gamma_2^1\left(e_t - e^*_t\right) + \gamma_2^2\left(e_t - e^*_t\right)\right] + u_t \quad (7)$$

where $\gamma_2^1$ is associated with large fluctuations and $\gamma_2^2$ is associated with small fluctuations. The results of estimating equation (7) are presented in table 3.

[7] We assume that large fluctuations are equal or greater than 1.5% (in absolute value) and small fluctuations are smaller than 1.5%. Under this assumption, roughly half of the observations in the full sample correspond to "large fluctuations".

**Table 3. Estimation of (7) by GMM**

| | $\bar{rr}$ | $\rho$ | $(\beta - 1)$ | $\gamma_1$ | $\gamma_2^1$ | $\gamma_2^2$ | $J - Test$ |
|---|---|---|---|---|---|---|---|
| Non Targeting Period | 0.060 | 0.871 | 0.134 | 2.566 | 2.462 | -0.415 | 2.9 |
| (1986.01-1990.08) | (0.00) | (0.00) | (0.05) | (0.16) | (0.15) | (0.38) | (0.01) |
| Targeting Period | 0.055 | 0.873 | 0.471 | 0.714 | 0.660 | $-0.203$ | 4.8 |
| (1990.09-2001.10) | (0.00) | (0.02) | (0.12) | (0.25) | (0.23) | (0.47) | (0.01) |

$J - Test$ is the test for overidentifying restrictions that has a distribution $\chi^2_{19}$.

Standard Errors in parentheses ()

$p$-values in brackets []

According to the above results, there is a nonlinear response of the CB to real exchange fluctuations; in both sub-periods responses to large deviations are significant, whereas, reactions to small ones are not different from zero.

On the other hand, responses to larger deviations, in the non-targeting period, are considerably higher than in the targeting period. This difference may signal different objectives in each period and is consistent with the view that a concern of the CB, in the late 80s, was to avoid external imbalances generated by RER misalignment (Magendzo, 1997).

## 6 Conclusions

This paper provides empirical evidence on the way in which the Chilean CB designs its monetary policy. We find evidence that the CB has been forward looking: it responds to anticipated inflation as opposed to lagged inflation. Furthermore, we conclude that the CB has some implicit objectives; avoiding output and exchange rate deviations from equilibrium. Therefore, even when inflation is under control, the Central Bank reacts to both real exchange rate and output deviations.

On the other hand, the Central Bank's reaction to exchange rate deviations is nonlinear; it reacts more strongly to large deviations rather than to small ones. This is true in the two sub-samples considered. This provides evidence that the Central Bank either tries to avoid excessive exchange rate depreciations (fear of floating), or to control appreciations that may reduce the competitiveness of the economy.

This paper derives long run deviations in the relevant variables by fitting structural time series models. We believe this is a better alternative than other *ad-hoc* detrending procedures. One limitation, specially in the case of RER deviations, is that, even if this is a better statistical procedures, it may not correspond to RER deviations derived from a specific economic model of RER determination.

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