THE CHILEAN EXPERIENCE WITH INFLATION TARGETING

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I dedicate this dissertation to my fiancée, Carolina, who encouraged me as I completed my PhD, as well as throughout the last, and best, three years of my life.

1 Introduction

In 1990 New Zealand and Chile became the first countries to implement inflation targeting, a monetary policy that uses announced inflation targets as a nominal anchor. Since that time, eighteen other countries have adopted similar policies, bringing the total number of countries that explicitly target inflation to twenty.

Inflation targeting imposes several conditions that are highly desirable for any monetary regime: central bank independence, an explicit commitment to price stability, accountability for policy results, and good information channels among economic agents. However, strict adherence to announced targets may also expose an economy to large variations in output, especially in response to external shocks.

Ten countries -New Zealand, Canada, U.K., Sweden, Finland, Australia, Spain, Peru, Chile and Israel- adopted inflation targeting between 1989 and 1994. Of these, only the last three are considered emerging market economies. Ten other countries adopted inflation targeting in a second round that started in 1998 and has not yet ended: the Czech Republic, Korea, Poland, Mexico, Brazil, Colombia, South Africa, Thailand, Switzerland, and Norway. The latter group is dominated by emerging market economies.

Empirical studies have concentrated on testing the effectiveness of inflation targeting in industrialized economies, perhaps because of their longer experience and better data availability. Nevertheless, more than half of the countries now targeting inflation are emerging market economies. The performance of inflation targeting in these countries has not been sufficiently studied.

In this paper I estimate a structural econometric model of Chile, the country with the

longest experience of inflation targeting, and an emerging market economy. I will attempt to determine whether the government has been targeting variables other than inflation. Also, I will address the question of whether the monetary authority has been forward or backward looking. Finally, I will test whether inflation targeting has been a credibility-enhancing mechanism for the Chilean Central Bank.

The rest of this paper is arranged as follows. Section 2 defines inflation targeting. Section 3 describes the performance of countries that have targeted inflation over the last thirteen years. Section 4 analyzes the particular experience of Chile, before and after the implementation of inflation targeting. Section 5 presents a structural model of a small economy. Section 6 estimates that model for Chile. Section 6.1 analyzes the results. Section 7 examines whether inflation targeting enhanced central bank credibility in Chile, and Section 8 concludes.

2 Literature Review

There is no consensus as to the criteria that a monetary policy must satisfy in order for it to be labelled as inflation targeting.[1] However, the main factors are clearly defined by Mishkin (1999) and Mishkin and Savastano (2001). Specifically, inflation targeting requires (i) a public announcement of an inflation target by the central bank, the government, or both, which will be pursued in a particular time frame; (ii) an explicit institutional commitment of the monetary authority to focus in price stability as its primary goal; (iii) the development of a series of econometric models that allow the monetary authority to fully understand the transmission mechanisms in the economy; (iv) setting the appropriate channels of communication between the monetary authority and economic agents; and finally, (v) a mechanism to make the monetary authority accountable for the outcome. The authors completed their definition arguing that inflation targeting entails "much more" than the announcement of numerical targets for inflation for the following year without targeting inflation in the strict sense.[2]

Amato et al. (2002) argue that, although these criteria seem appropriate, they do not define the policy framework properly, since central banks in some industrialized countries that are not explicitly targeting inflation posses many of these characteristics (i.e. Swiss National Bank before January 2000 and the European Central Bank). In addition, they argue, inflation targeting has evolved over time in such a way that the definition needs to be more open in order to incorporate recent targeters, most of them emerging market economies.

[1] See Agenor (2001), Schaechter et al. (2000), Carare et al. (2002), Sterne (2002) and Amato et al. (2002).

[2] The emphasis responds to the practice of policy makers in EME, who have permanently reported numerical inflation targets as part of the economic program of the government without being inflation targeters.

Bernanke and Mishkin (1997) define inflation targeting as a monetary "framework with constrained discretion." Specifically, inflation targeting is a complete policy framework that increases the transparency and coherence of policy. Thanks to its forward-looking components, inflation targeting constrains the authority from promoting policies with negative long run effects in terms of inflation and output. In addition, it also provides some discretion for dealing with short run volatility.

Walsh (2000) argues that inflation targeting may benefit even a monetary authority that is committed to price stability and low inflation, because explicit targeting imposes an additional cost to inflating, and therefore reduces the time-consistent inflation rate. In such a case, inflation targeting might help the authorities in some emerging markets who seem committed to low inflation, but who also face a lack of credibility due to the nation's long history of irresponsible monetary policy, problems generated by fiscal dominance and lack of central bank independence.

A well implemented inflation targeting framework not only provides a nominal anchor, but also makes compulsory the coordination of fiscal and monetary policies towards the common objective of low and stable inflation. However, the benefits do not come without a cost, and the monetary authority faces many difficulties under an inflation targeting regime. Bernanke and Woodford (1997) and Svensson (1997a) argue that inflation targeting may be difficult to implement due to the imperfect control over inflation. Since monetary policy operates with a lag, any attempt at *fine tuning* may cause inflation to deviate from the target, and, in turn, reduce central bank credibility. In addition, the central bank will lose some of its ability to stabilize output, since an accommodating monetary policy may cause

the inflation target to be missed.

Implementing and monitoring the mechanism are other difficulties of inflation targeting. First, inflation is partially determined by previous decisions and contracts, which means that the monetary authority can affect it only partially and with a lag. Besides, since there are other factors in addition to monetary policy that will affect the evolution of prices, some of them unforecastable, the central banker can always blame these other factors and argue against being held accountable for the difference between observed inflation and the announced target.[3] One way to improve monitoring and implementation, first suggested by Bowen (1995) and fully described by Svensson (1997a), is to realize that inflation targeting implies inflation forecast targeting, and to use the central bank's inflation forecast as an intermediate target. In such a case, the monetary authority is going to react to deviations of their inflation forecast from the announced target.

The empirical literature on inflation targeting can be roughly divided into three categories.. First, there are studies that analyze inflation targeting by comparing the performance of a group of inflation targeters to the performance of a control group. Second, there are cross-country studies that compare performance among inflation targeters. Third, there are country studies that analyze the macroeconomic performance before and after inflation targeting was adopted, and the stabilizing properties of this monetary framework. Although the literature is extensive in each category and continues growing as more countries opt for this framework and more data becomes available, I will describe the major contributions to the literature to this point.

[3]State-controlled prices are frequently blamed for generating excessive inflation in emerging market economies, since they represent and important component of consumer price index calculation.

Among the studies included in the first category it is important to mention Laubach et al. (1997) and Mishkin et al. (2001a), who found that the use of inflation targeting contributed significantly in the disinflation process of the 90's among industrialized inflation targeters. In the same line of analysis, Bernanke et al. (1999), found that, although the contribution of inflation targeting to disinflation was statistically significant among the industrialized countries, inflation in the targeting countries did not reach levels lower than in the non-inflation targeters. Johnson (2002) used a panel of five inflation targeting and six non-inflation targeting countries during the period 1991-2001, and found strong evidence of a large reduction in the level of expected inflation after the first targets were announced. However, after controlling for country and year effects, global disinflation, and the business cycle, the variability of expected inflation and the average absolute forecast error did not fall in targeting countries relative to those in non-targeting countries. In a different approach, Cechetti and Ehrmann (2002) asked if the aversion to inflation volatility changed during the 90's, and if so, if that change was stronger among inflation targeters. They found that aversion to inflation variability increased in every country in a sample of fourteen non-inflation targeters and nine inflation targeters, increasing more for the latter group, but by a modest amount.

In the second category it is important to include a recent study by Jonas and Mishkin (2003) covering the Czech Republic, Poland and Hungary. These countries progressed well in terms of reducing inflation, but frequently missed their targets by a wide margin, due to the difficulty of forecasting inflation in transition economies. In a different region, Corbo, et al. (2001) compare the implementation and performance of inflation targeting in Chile, Peru,

Mexico, Colombia and Brazil. They found that this framework was successful in reducing inflation, measuring "success" by reaching the target, and facing lower sacrifice ratios and output volatility after inflation targeting was adopted. Schmidt-Hebbel et al. (2002b) considered the performance of inflation targeting under dirty floats in Mexico, Chile and Brazil, and found it to be a successful mechanism, using the same definition of success as Corbo, et al. (2001).

Among the country studies included in the third category it is important to mention Debelle and Wilkinson (2002) for Australia, Bogdnaski et al. (2002) for Brazil, Schmidt-Hebbel and Tapia (2002a) and Corbo (1998) for Chile, and Drew (2002) for New Zealand. Each study argues that inflation targeting has successfully reduced inflation without imposing excessice costs in terms of lost output or output volatility.

This study falls in the last category; it is a country study for the Chilean economy. However I pay less attention to comparing economic performance before and after inflation targeting was adopted, but concentrate instead on the impact of inflation targeting after adoption.

There are some previous attempts to estimate a structural model for the Chilean economy. Corbo and Fischer (1994) estimate a small structural model similar to Bruno (1978) and Corbo (1985),[4] concentrating on the link between prices and wages during the 1970's and 1980's. A newer study by Corbo (1998) analyzes the first eight years of inflation targeting in Chile with a simple structural model, but with some specification problems. Each of the three equations of the structural system is estimated individually and fail to exploit

[4]This study analyzes the Chilean case during the period 1976-1982.

the possible correlations among the errors. In addition, the monetary reaction function and output gap are exogenous variables. Corbo's (1998) was the basis for many working papers,[5] but I have not found in the literature another study of inflation targeting in Chile that uses a structural small-open-economy model.

3 Performance Among Inflation Targeters

In the thirteen years since it was first implemented by New Zealand and Chile, a total of twenty countries have adopted inflation targeting in two rounds. The first round started in 1990, ended in 1994, and was dominated by industrialized countries: New Zealand, Canada, U K, Sweden, Finland, Australia, Spain, Peru, Chile and Israel (the last three are considered emerging market countries). The second round started in 1998 and has not yet ended.[6] It also includes ten countries, but this time is dominated by emerging market economies: the Czech Republic, Korea, Poland, Mexico, Brazil, Colombia, South Africa, Thailand, Switzerland and Norway.[7]

It is important to notice that, when inflation targeting was adopted, inflation differed widely among the countries included in each group (Figure 1). Peru's inflation reached 33.7% in January 1994, while at the other extreme, Thailand's inflation in April 2000 was only 1.6%. Given that both of these countries have been successfull in meeting their proposed targets, it seems that a particular level of inflation is not an initial condition for successful inflation targeting. In addition, we can say that all of the countries that adopted inflation targeting

[5] See Corbo et al. (2001) for a survey in the topic.

[6] Nevertheless, I only include countries that adopted this framework between 1998 and 2002.

[7] For an excellent cross-country comparative information about inflation targeting countries and their results with this framework see Schmidt-Hebbel et al. (2002b)

as a monetary framework are, by 2004, still living with it.[8]

In comparison to the decade of high inflation during the 1980's, the 1990's were characterized by a slight reduction of inflation worldwide. The world average inflation rate was reduced marginally, from 14.97% to 14.49%, with industrialized and developing economies reducing their inflation rates from 5.89% to 2.72% and from 35.43% to 32.54%, respectively (Figure 2 and 3). Even though this progress does not look impressive in general terms, most of the worldwide disinflation occurred in the last four years of the 1990's. Average world wide inflation from 1990 to 1995 was 21.01%, compared with a 7.98% average inflation from 1996 to 1999.

Many factors have contributed to this reduction in global inflation. Political and economic reforms have created institutions and mechanisms that promote responsible fiscal policy, central bank independence, openness to trade, and capital market integration. The supporters of these institutional reforms claim that inflation targeting has been an important component.

This section describes the disinflation process in those countries that target inflation, without suggesting that this mechanism was the only cause of the reduction in inflation. I separate countries that target inflation into two groups, industrialized countries and emerging market countries. The nine industrial countries that are targeting inflation are Australia, Canada, New Zealand, Sweden, Finland, Spain, U.K., Norway, and Switzerland. The eleven emerging market countries that are targeting inflation are Chile, Israel, Czech Republic, Brazil, Poland, South Africa, Thailand, Colombia, Korea, Mexico, and Peru.

[8]The only exceptions are Spain and Finland when joining the European Union.

Table 1 reports inflation as measured by the change in the Consumer Price Index (CPI) for both groups of countries. In the first two columns, I compare inflation in the two periods, 1980-1989 and 1990-2002.[9] Inflation was reduced substantially in both the industrialized and the emerging market countries. Average inflation in the industrial countries decreased from 7.9% in the 80's to 2.7% in the period 1990-2002. In the emerging market countries, excluding Brazil, Poland and Peru,[10] inflation rate fell from 34.8% to 9.1%. If instead I divide the sample for each country by the first quarter of inflation targeting (Columns III and IV), the results are very similar. In this case, inflation was reduced from 7.5% to 2.1% in the industrial countries and from 29.9% to 8.2% in the emerging market countries.

In order to see the difference between the inflation rate *before and after* inflation targeting was set in place, I propose an additional time setting. Consider now the variation in average inflation between period $t-4$ (Column V), measured in quarters, and $t+4$ (Column VI), where t is the quarter in which inflation targeting was first implemented. Industrialized countries experienced an average reduction of 1.1% in their inflation rate, from 3.4% to 2.3%. Among them, only New Zealand and Australia did not experience a reduction. Emerging market countries experienced an even stronger disinflation during the two-year window, from 15.9 to 7.8%, with only Brazil and Thailand posting an increase. This reduction represented a victory for most of the emerging markets included in the group, moving from high and

[9]The second period is longer to incorporate countries that have adopted inflation targeting since 2000, and to capture the recent strength of the disinflation process.

[10]Brazil (from 318.3% to 350.3%), Poland (from 141.2% to 14.8%) and Peru (from 2245.6% to 8%) are excluded from the group of emerging countries for this calculation because of the high inflation rates. Including them, the average inflation for both periods considered are 298.3% and 40.5%, respectively. However, these countries experienced the fastest reduction in inflation. Brazil, Poland and Mexico reduced their annual inflation rates from 4116%, 805% and 5431% in 1990, respectively, to one digit 7%, 15% and 9% annual inflation by 1997, respectively.

steady inflation to single-digit inflation.

After describing average inflation, it is also important to examine inflation volatility.[11] Unfortunately, in this case the evidence is far from straight forward. The volatility of inflation has increased in some countries and decreased in others. Inflation volatility increased on average for industrialized inflation targeters. Yet it has decreased for emerging countries, the countries that appear to have benefitted the most from inflation targeting. If the overall shocks hitting the economy decline after the adoption of inflation targeting, which seems to be the case for emerging market economies, inflation volatility will fall.

From these comparisons, inflation targeting appears to be a successful mechanism, at least for reducing inflation. However, presenting the evidence in this way has a important drawback. This simple look at the data ignores that inflation has also declined in non-targeting countries. To identify the effect of inflation targeting, a more disciplined approach, based on an economic model, is needed. This is the approach that I take in section 5, below.

One last measure of the performance is to analyze how successful the authorities were in reaching their announced targets, and in particular, how Chile performed among the inflation targeting countries. This time the analysis focuses on all inflation targeting countries classified as emerging market economies (Table 3). Column II reports the average monthly absolute deviation of actual inflation from the announced target.[12] It shows that on average, inflation deviated from announced targets by 2.3%, with a wide range of results. On one hand, Chile has the lowest average deviation (1.1%) during a 13 year period. On the other

[11] Measure as the standard deviation of inflation relative to average inflation

[12] In the case of range targets, the deviation measures the difference between actual inflation and the center of the band. For point targets, the deviation is straight forward. In the case of changing targets, the calculations considered the deviation of actual inflation from the interpolated value between specific targets.

hand, Brazilian inflation deviated consistenly from announced targets during its four year sample period, with an average deviation of 4.1%. Column III reports standarized average deviations from inflation targets in order to present a measure for cross country comparisons. Again Chile has the best performance, Brazil the worst.

Although the average deviation from target is important, it is also important how often inflation deviates from target, since persistent deviations will reduce central bank credibility. Column IV shows the percentage of total months when observed inflation was above or below the announced target by 1%. Chile is a remarkable case. It only has 19% of the total number of months in a 13-year period, second lowest after Colombia and Peru, both with 17% of total months. At the other end of the spectrum, Brazilian inflation was above target in 60% of total months. Finally, perhaps the measure that is more evident to economic agents is the length of the deviation period, and consequently the one that affects credibility the most, and therefore, the way inflation expectations are created. Column V reports the average length of the deviation period. Brazil shows the worst performance again, with an average period of thirty three months with inflation above target, extremely highy considering that inflation targeting started to operate in June 1999.

4 Monetary Policy in Chile

After two unsuccessful attempts using a nominal exchange rate anchor in 1959-62 and in 1979-82, the Chilean monetary authorities, recently invested with a high degree of independence in December 1989, were looking for a completely new mechanism to gain credibility and

reduce rampant inflation.[13] A third attempt to use the nominal exchange rate as an anchor was rejected. Targeting monetary aggregates was also rejected because of the high volatility of money demand. Instead, the Chilean Central Bank opted for inflation targeting. I consider that Chile started to target inflation when the first target was announced, although under the classification proposed by Mishkin and Schmidt-Hebbel (2001) a country cannot be considered a full-fledged inflation targeter if an exchange rate band is used. Chile used a crawling peg during the period 1990-1999, free floating the Peso only after July 1999[14].

After a decade in which the average inflation rate was 21.5%, the Chilean authority announced in September of 1990 the first inflation target range between 15% to 20% to be reached by December of 1991. For the next ten years, each September the Central Bank announced the annual inflation target to be attained thirteen months later, by December of the coming year. After a stationary rate of inflation was reached in 2001, a target range between 2% and 4%, centered on 3%, has been set indefinitely.

Among the countries included in the first round of inflation targeters defined in Section 3, only Chile and Israel opted for a gradual approach to reducing inflation. Their initial inflation rates were high relative to the steady-state level achieved and both countries used inflation targeting to build credibility and change the way expectations of inflation were formed. In particular, the main reason for a slow disinflation process in Chile was the high indexation of wages and prices, evident even in contracts involving the government, requiring longer

[13]Given the expansionary macroeconomic policies of the new administration, the 12-month inflation rate (11:1988-11:1989) reached 21.1% and accelerating. For more historical details see Corbo (1998).

[14]In a non-empirical study, Amato et al. (2002) suggest that inflation targeting has been introduced effectively in emerging economies without satisfying the basic requirements suggested in the literature, and also that exchange rate objectives were more important in emerging market economies in comparison to industrialized ones, showed by the coexistence of inflation targets and exchange rate bands

periods of time before inflation converged to a low stationary rate. Industrialized countries had low initial rates of inflation and only required an average of one year to reach their stationary inflation rate. (Landerretche et al., 1999).

4.1 Inflation Targeting Design in Chile

Every country adopting inflation targeting has customized this monetary framework in various ways. Specifically, authorities have to chose the price-index variation to target, the targeting horizon, whether to target an inflation point or an inflation range, and escape clauses when the inflation target is missed. (Carare et al., 2002). Below I describe the main considerations for the Chilean inflation targeting plan.

The choice of the appropriate price index faces a trade-off between controllability and credibility. On one hand, the variation in headline Consumer Price Index (CPI) is easily understood by economic agents and perceived to be less likely to be manipulated by authorities. However, the basket of goods and services used in the calculation of the CPI includes components that are beyond the control of the central bank, especially government-controlled prices and the terms of trade. On the other hand, core inflation is less volatile and reflects the impact of monetary decisions on prices without the distorting effects of regulated prices, but it is not always fully understood by common individuals, imposing avoidable costs in terms of central bank credibility. The decision in this respect was relatively easy. Since the authorities in Chile were looking for a credibility-enhancing framework that builds a reputation for the Central Bank as committed to low and stable inflation, they decided to target the variation in headline CPI.

Another decision was the type of target: a target point or a target range. A target point requires a stronger commitment from the central bank to reach the announced rate of inflation, since it implies a fast reaction tightening or softening when expected inflation appears to deviate from the target. However, point targets increase the probability of missing the announced target when there is an unforecastable shock or when the transmission mechanism from monetary policy to prices does not work as expected. Reaching the announced point targets in these circumstances could produce large costs in terms of output volatility. On the other hand, a target range gives the central bank more flexibility and discretion in policy making, especially to proceed with output stabilization if needed. However, it also imposes costs in terms of credibility, and this is related to the width of the band. A target range also exposes the authorities to expansionary pressures from the central government and private sector when central bank independence is not fully institutionalized.

Chilean authorities adopted, at different times, both types of targets. Figure 4 shows the inflation targets and observed inflation of Chile during the period 1991-2004. In 1990, when inflation targeting was first implemented, a target band was defined for December 2001. Given the low credibility of the former monetary authorities, the highly indexed economy, and the limited knowledge of how the agents form expectations, the Central Bank opted for a target band. After the mechanism was in place and the first targets were successfully reached,[15] the central bank, feeling it had gained credibility, changed to a point target. Only in 2001, after reaching a long run stationary rate of inflation, was an unlimited range target again set in place.

[15] Authorities announced target bands for 1991, 1993 and 1994. A point target was announced for 1992, but observed inflation was substantially lower.

Time horizons were also set. Since the economy started from a high inflation rate in 1990, monetary authorities defined thirteen-months-ahead targets every September. By announcing targets and, most importantly, reaching them, the authorities defined the disinflation process they were pursuing, producing a favorable change in expectations of future inflation. Longer horizons are only advisable to central banks with high credibility and when inflation is close to its stationary rate. In fact, after Chile reached a stationary level of inflation, a new band was set indefinitely. The main problem with short horizons is the possibility that the monetary authorities would overreact when price shocks disturb the economy. Such an overreaction could produce excessive variability in other macroeconomic variables if the inflation target is to be met.

In terms of transparency and information available to the public, a cornerstone of an inflation targeting framework, there are two regular publications. Starting in May 2000, the Chilean Central Bank releases every four months an inflation report, similar in format to the Beige Book elaborated by the Federal Reserve Board in the United States. It presents the evolution of inflation, a forecast of future inflation and output growth, and a description of the risks that may affect the forecasts for the following twelve and twenty four months. In addition, the minutes of the monetary policy meetings held on a monthly basis are available to the public with a three month delay. High standards of transparency allow the agents to focus their attention on inflation forecasts, reducing the degree of price indexation in the Chilean economy.

The final decision in adopting this framework is to define the appropriate mechanism to hold the monetary authority accountable for the outcome. Different mechanisms have been

adopted among inflation targeting countries. For example, in the early stages of inflation targeting in New Zealand, the central bank director could be fired if inflation deviated from its announced target by a large amount. In neighboring Australia, the central bank director's compensation was linked to the deviation of actual inflation from the announced target. Chile and Mexico, on the other hand, require that the monetary authority submit a letter to the President and to Congress explaining why the targets were missed and what measures will be taken in order to avoid future deviations.

As its monetary instrument, the Chilean monetary authority used the **real** rate[16] of interest on the PRC 90-day indexed bonds from 1985 to 1995. In September 1995, the authority also began using the real overnight interbank rate, but the rate of interest of the PRC 90-day bond was still the monetary policy rate of reference.[17]

4.2 Close to the Zero-Bound

In 1977, the military regime of Augusto Pinochet introduced an indexed unit of account denominated *Unidad de Fomento* or UF.[18] Private contracts and transactions with the central government were denominated in UF to preserve their value in real terms. Starting in 1985 and for sixteen years, the Chilean Central Bank issued bonds denominated in UFs, which in turn implies a monetary authority using some sort of real interest rate in its policy making.

[16] This real interest rate is actually linked to past inflation instead of future expected inflation rate, and is known in the Chilean economic literature as *ex-ante real interest rate* or *pseudo-real interest rate*

[17] Since 1995, the central bank committed itself to guide the interbank rate toward its monetary policy rate of reference using the reserves ratio, open market operations, REPO and Reverse REPO operations.

[18] The daily value of the UF calculated one month in advance, based on the inflation rate of the previous month.

The generalized use of UF imposed serious difficulties to the disinflation process, since inflation inertia and backward looking were officially institutionalized. This also explains why the convergence to the stationarity inflation rate took nine years.

As shown in Figure 4, the reduction in interest rates and inflation brought the monetary policy rate close to zero by June 2001. The combination of a higher probability of negative inflation and an expansionary monetary policy pursued since January 2001 resulted in higher risks of a negative interest rate. For this reason, the Central Bank of Chile replaced its monetary policy instrument in August 2001, shifting from a monetary policy rate linked to the UF to a nominal monetary policy rate denominated in Pesos.[19]

The decision was well timed. Only thirty months later the inflation rate in Chile momentarily reached the negative territory, and the monetary policy rate, now in nominal terms, still had plenty of room to conduct an expansionary monetary policy.

5 A Structural Small-Open-Economy Model

In this section I present a simple rational-expectations structural model based on the closed economy model of Fuhrer and Moore (1995a, 1995b) and Fuhrer (1994, 1997). The model is modified to consider a small open economy as in Svensson (2000) and Batini et al. (1999).[20] The main justification for including open-economy characteristics is that all inflation targeting countries are quite open[21] economies (Table 4), and Chile in particular is the most open

[19] This change in interest rates definitions was denominated *Nominalización*. For a detailed explanation, see Fuentes et al. (2002)

[20] Previous formal work of inflation targeting in closed-economies can be found in Svensson (1997a) and Svensson (1997b)

[21] Measured as total exports/GDP. In addition, Chile had 37 bilateral trade agreements by December 2003, the highest among emerging market countries.

economy in Latin America. I adopt the convention that for an economy to be considered small, exports do not affect prices in international markets, and the price of imported goods and foreign interest rates are exogenous.

The basic model consists of four equations: an aggregate spending relationship, an aggregate supply or inflation equation, a monetary reaction function and an interest parity condition. In addition, the model includes a long-term real interest rate identity to create the link between the short-term interest rate set by monetary authorities and the interest rates relevant for investment and consumption decisions.

5.1 Aggregate Spending relationship

The Aggregate Spending relationship, or IS Curve, follows Fuhrer and Moore (1995a, 1995c), except that it includes the real exchange rate, and can be written as

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \alpha_r r^L_{t-1} + \alpha_q q_t + \varepsilon_t \tag{1}$$

This aggregate spending representation relates the output gap (y) to its own first two lags, one lag of the real interest rate (r^L), the real exchange rate (q), and a zero-mean i.i.d. demand shock (ε). The real exchange rate is given by $s_t + p^*_t - p_t$, where p_t is domestic price level, p^*_t is foreign price level, and s_t is nominal exchange rate. All variables, except the real interest rate, are measured in log terms and all coefficients are assumed to be positive.

Under the expectation hypothesis of the term structure, the variable r^L_t represents the real interest rate on a zero coupon bond with maturity T, which fulfills $r^L_t = \frac{1}{T}\sum_{\tau=0}^{T-1} E_t r_{t+\tau}$. This is the link between the short term interest rate determined by the monetary authority

and the long term real interest rate. This definition is similar to the one proposed by Fuhrer et al. (1995a), which in turn proceeds from an intertemporal arbitrage condition that equalizes expected real holding period yield and the yield of treasury bills.

Equation (1) assumes that the one period lag of r^L is the variable that determines aggregate consumption and investment decisions, and hence the output gap and inflation. It also relates the long-term bond rate to current nominal interest rates and their future expectations via the interest term structure. This is the first channel of monetary transmission in this model.

The second channel of monetary transmission is through the real exchange rate. The real exchange rate directly affects the price of exports and imports, with the consequent impact on aggregate demand and on consumer prices, the latter in proportion to the importance of imported goods in the consumer price index. In addition, q_t affects the cost of imported inputs to production. For example, a real depreciation of the local currency (an increase in q_t) makes domestically produced goods more competitive with foreign goods, shifting demand from foreign to domestic output.

Finally, I assume that, for this small open economy model, foreign income and consumption are exogenous, and their impact on domestic aggregate spending is fully captured by the error term ε_t.

5.2 Inflation Equation

The inflation equation comes from Fuhrer and Moore's (1995b) model of multi-period, overlapping nominal contracts. The Fuhrer and Moore specification differs from Taylor (1980),

which considers that prices are sticky and a change in the level of inflation has no impact on output since there is no inertia in the rate of inflation. Fuhrer and Moore suggest that inflation, in addition to the price level, exhibits some degree of stickiness, limiting the flexibility of current inflation to jump in response to new information. They define current inflation as a function of lagged and expected future values of inflation[22] and lagged and current values of output. I add one lagged expectation of the current real exchange rate to the Fuhrer and Moore formulation in order to incorporate the external sector in the domestic inflation process.

The inflation equation is thus given by

$$\pi_t = \delta_\pi \pi_{t-1} + (1 - \delta_\pi)(E_t \pi_{t+1}) + \delta_y (y_t + y_{t-1}) + \delta_q E_{t-1} q_t \tag{2}$$

where all the coefficients are positive. The specification in Equation (2) includes inflation persistence due to sluggish adjustment given by the backward looking component π_{t-1}. It also includes a forward looking component, π_{t+1}, based on the expectations of economic agents at time t. The term $E_{t-1} q_t$ represents the effect of expected costs of imported intermediate inputs on the inflation measure. Agents' expectations of a real depreciation (an expected increase in q_t) increase the overall price level by the pass-through effect.

Equation (2) is similar to Svensson's (2000) Phillips Curve, which is derived from first-order condition of an optimization problem and is therefore grounded in microeconomic foundations.

Using $E_t \pi_{t+1} = \pi_{t+1} + (E_t \pi_{t+1} - \pi_{t+1})$, Equation (2) can be written as

[22] See Calvo (1983) for the inclusion of expectations of future inflation in the Phillips curve.

$$\pi_t = \delta_\pi \pi_{t-1} + (1 - \delta_\pi)\pi_{t+1} + \delta_y(y_t + y_{t-1}) + \delta_q q_t + \eta_{t+1} \tag{3}$$

where $\eta_{t+1} = (1 - \delta_\pi)(E_t\pi_{t+1} - \pi_{t+1}) + (E_{t-1}q_t - q_t)$.

5.3 Monetary Reaction Function

Consider a monetary authority that uses the short-term interest rate as the instrument to conduct monetary policy and that attempts to eliminate any deviation of inflation from its announced target. I allow for the possibility that the central bank also targets deviations of output and the exchange rate from its long run equilibrium level.

I introduce three changes to the interest rule proposed by Clarida et al. (2000). First, the interest-rate targeting rules used in the literature (Clarida et al. (2000), Taylor (1993)) were specified for a closed economy model. I therefore modify the interest-rate rule to include the exchange rate. This allows me to consider the interaction of the exchange rate and monetary policy. Second, I use a rule based on real interest rates[23] instead of one using an interest rate rule based on nominal interest rates. Third, I allow inflation rate targets to change during the period of analysis, instead of being held constant.[24] In this way, the monetary policy function in the model is able to capture the fact that the monetary authority can change future inflation targets depending on economic progress, defining a disinflation path towards their long term inflation objectives.

The interest rate rule is

[23] See Section 4.2.

[24] In Clarida, Gali and Gertler (2000), the Federal Reserve Board is assumed to pursued a fixed inflation rate during the whole period of analysis.

$$r_t^* = r^* + \beta_\pi(E_t\pi_{t+k} - \pi_{t+k}^T) + \beta_y E_t y_{t+q} + \beta_{\overline{q}}\overline{q}_t \tag{4}$$

The monetary authority reacts to deviations of its own forecasts of future inflation at period $t+k$ from its corresponding target. It also reacts to movements in its own output gap forecast at period $t+q$, and to changes in the nominal exchange rate $(\overline{q}_t)$,[25] again based on the best estimate of the current state of the economy and the expected path of exogenous variables. It is important to emphasize that it is the nominal exchange rate that appears in the monetary reaction function. Although the authorities analyze the implications of real interest rate fluctuations, the movement in the nominal exchange rate has a greater effect on agents' expectations. The equilibrium long-run real interest rate is represented by r^*.

This definition considers an immediate adjustment of monetary policy rate to its target level, ignoring the desire of monetary authority to smooth the interest rate path. To correct for this, I follow Clarida et al. (2000) and specify a relationship that allows for partial adjustments of the real interest rate, r_t, to its target value, r_t^*.

$$r_t = \rho(L)r_{t-1}^* + (1-\rho)r_t^* + \Theta_t \tag{5}$$

where Θ_t is an i.i.d. shock $\backsim (0, \sigma^2)$, and ρ is a measure of the degree of interest rate smoothing. Also, $\rho(L) = \rho_1 + \rho_2(L) + ... + \rho_n(L)^{n-1}$, where $\rho(1) = \rho_1 + \rho_2 + ... + \rho_n = \rho$.

Combining Equation 4 with Equation 5, and using the expectations definition, the interest rate rule for this small open economy is,

[25] During the period 1990-1999, Chilean monetary authority had objectives of limited current account deficits. However, I only allow the authority to react to deviations of inflation, output, and changes in the nominal exchange rates.

$$r_t = \rho(L)r_{t-1} + (1-\rho)\left[r^* + \beta_\pi(\pi_{t+k} - \pi^T_{t+k}) + \beta_y y_{t+q} + \beta_{\bar{q}}\bar{q}_t\right] + \kappa_t \tag{6}$$

where $\kappa_t = (1-\rho)\left[(E_t\pi_{t+k} - \pi_{t+k}) + \beta_y(E_t y_{t+q} - y_{t+q})\right] + \Theta_t$ is the error term,[26] which includes the error in forecasting and the error in interest smoothing. Under rational expectations κ_t is assumed to be orthogonal to any variable in the information set available at time t.

The response of the monetary authorities to changes in expected inflation with respect to the target, output gap, and changes in the nominal exchange rate depends on the signs and magnitudes of β_π, β_y, and $\beta_{\bar{q}}$. I consider that policy leans against the wind in the sense that all coefficients are positive. A forward-looking monetary reaction function like the one proposed here increases the monetary policy rate when (i) inflation expectations are above the announced target, (ii) expected output is above the long run steady state, and/or (iii) changes in nominal exchange rate might have a negative effect in the economy.

5.4 Interest Parity Condition

The inclusion of a standard interest parity condition incorporates in the model the relationship of a small economy with the external sector. The interest parity condition is given by $i_t - i^*_t = E_t s_{t+1} - s_t + \varphi_t$, where i^*_t is the foreign nominal interest rate (exogenous), φ_t is the foreign-exchange rate risk premium,[27] and s_t is the nominal exchange rate.

Writing the interest parity condition as a function of real exchange rate instead of nom-

[26] For values of k and q different than one, the error term κ_t follows a MA(a), where $a = \max\{k, q\} - 1$.

[27] which includes any exogenous residual disturbances to the exchange rate, including, among others, changes in portfolio preferences and credibility effects.

inal, replacing s_t with $q_t - p_t^* + p_t$, and solving for the current expectation of future real exchange rate, the current expectation of the future real exchange rates is

$$E_t q_{t+1} = i_t - i_t^* + q_t - E_t \pi_{t+1} + E_t \pi_{t+1}^* - \varphi_t \tag{7}$$

The interest parity condition imposes a restriction on monetary policy. For example, in order to keep the future expected real exchange rate constant, an increase in the value of the policy instrument controlled by the monetary authority in the current period must be accompanied by a combination of lower real exchange rate (an appreciation of the currency), a higher expected future inflation, and a higher exchange rate risk premium.

Solving Equation 7 for q_t, and using the Fisher Equation to include the real interest rate for the domestic economy, the current real exchange rate is given by

$$q_t = E_t q_{t+1} - r_t + i_t^* - E_t \pi_{t+1}^* + \varphi_t \tag{8}$$

Defining the expectations at period t of foreign inflation and the expected real exchange rate as $\pi_{t+1}^* + (E_t \pi_{t+1}^* - \pi_{t+1}^*)$ and $q_{t+1} + (E_t q_{t+1} - q_{t+1})$, respectively, I write the real exchange rate as a function of domestic and foreign real interest rate, exchange rate risk premium, and the error in forecasting domestic and foreign inflation, so that

$$q_t = q_{t+1} - r_t + i_t^* - \pi_{t+1}^* + \varphi_t + \zeta_{t+1} \tag{9}$$

where $\zeta_{t+k} = (E_t q_{t+1} - q_{t+1}) - (E_t \pi_{t+1}^* - \pi_{t+1}^*)$.

6 Estimating the Model for the Chilean Economy

Collecting the equations defined in section 5, the model to be estimated is defined by:

Aggregate Spending	$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \alpha_r r^L_{t-1} + \alpha_q q_t + \varepsilon_t$
Inflation	$\pi_t = \delta_\pi \pi_{t-1} + (1-\delta_\pi)\pi_{t+1} + \delta_y (y_t + y_{t-1}) + \delta_q q_t + \eta_{t+1}$
Monetary Policy	$r_t = \rho(L) r_{t-1} + (1-\rho)\left[r^* + \beta_\pi(\pi_{t+k} - \pi^T_{t+k}) + \beta_y y_{t+q} + \beta_{\bar{q}} \bar{q}_t\right] + \kappa_t$
Interest Parity	$q_t = q_{t+1} - r_t + i^*_t - \pi^*_{t+1} + \varphi_t + \zeta_{t+1}$

It contains only four equations and seventeen variables, but carries a considerable theoretical content and provides a stylized representation of the monetary policy transmission mechanism. In addition, at a tractable level, it possess a structure similar to the MEP1 Structural Macroeconomic Model for Chile, the model used by the Chilean Central Bank for monetary analysis and policy exercises.[28]

I estimate the vector of parameters $\boldsymbol{\theta} = [\delta_\pi,\ \delta_y,\ \delta_q,\ \alpha_1,\ \alpha_2,\ \alpha_r,\ \alpha_q,\ \beta_\pi,\ \beta_y,\ \beta_{\bar{q}},\ \rho,\ r^*]'$ using monthly data from Chile for the period 1990:9-2001:7 and Hansen's (1982) Generalized Method of Moments (GMM) procedure with correction for a MA(12) autocorrelation.

I define a vector $\mathbf{x}_t$ of instrumental variables. As instruments I use 1-6, 9, and 12 lagged values of the endogenous variables (y_t, π_t, r_t), as well as the same number of lags of each, the log money supply, the spread between domestic lending and borrowing interest rates, and international copper prices.

The beginning and end date of the sample responds to structural considerations. Even though the Central Bank authorities in Chile gained substantial independence in 1989, it was not until September of 1990 that the first inflation target was announced. This change

[28] The MEP1 model is described properly in Valdes (2003).

in monetary policy most likely produced a change in the way expectations were formed, and in the transmission mechanisms of monetary policy. At the other end of the sample period, July of 2001 was the last month that the monetary authority used ex-ante real interest rates as their policy instrument and the month when the process of *Nominalización* started. It is possible that no structural break occurred after July 2001, but the short length of a sample after that change does not provide enough data points to test it.

Given the frequency of the data, I chose as a proxy for output the Monthly Index of Economic Activity (IMACEC), calculated by the Chilean Institute of National Statistics. The deviations of the index from a long-term trend, was extracted using the Hodrick-Prescott Filter. Seasonal factors for the IMACEC, and other variables presenting seasonality, have been calculated with the X-12 Arima Model created by the Bureau of Labor Statistics (Felipe et al. 2002).

The exchange rate risk premium (φ_t) originally considered in this analysis uses the value estimated by Soto and Valdes (1999) for the Chilean economy during the period 1990-1999. Based on an ARCH-M model that defines the exchange rate risk premium to be a function of the volatility of the exchange rate. They found a strong, positive, and statistically significant risk premium of 4.59%, measured in annual interest rate equivalents.

From 1985 through 1995 the Chilean Central Bank used the real rate on indexed CBC paper of 90-day maturity (PRBC-90s) as its monetary instrument. Starting in May 1995, the bank publicly announced its policy rate and guided the market interbank rate towards the policy objective by conducting open-market operations. I use the *monetary policy rate* reported by Chilean Central Bank which considers this difference. In addition, in order to

test the structural stability of the monetary policy rule given these two sub-sample periods, I use a Chow test. The results confirm the null hypothesis that there is no structural break in May 1995.[29]

During the period considered in this sample but before the announcement of an indefinite stationary target band for December 2001, the Central Bank announced yearly targets. For this reason, $k = 12$ in Equation (6). In the same equation, I also assume that authority uses a one-year output forecast, so that $q = 12$ in Equation (6).

It is important to clarify the definition of the inflation target for any particular month. Since there are only explicit monthly targets for every December between 1991-2001, the monthly inflation target for January to November is the interpolated value between the previous and the next explicit target.[30]

In terms of foreign inflation, I use the IPE-Total, an index calculated by the Chilean Institute of National Statistics. It measures the change in producer price indexes, measured in dollars, among the main Chilean trade partners, weighting them with the relative importance in export and imports, excluding oil and copper.

Instead of using the definition of the long real interest rate (r_t^L) as presented in Section 5.1, I am using the average real interest rate the Chilean financial system charged on lending operations at three or more years.

[29] The critical $F_{17,84} = 1.74$ at $\alpha = 5\%$. The observed F is equal to 0.707

[30] For the first thirteen months of the sample, the interpolated value considers the inflation rate of July 2000 and the first announced target.

6.1 Results

For the sample considered, I assume the stationarity of both real interest rates and inflation rate, even though the null hypothesis of the existence of unit root seems hard to reject in both cases. The Chilean experience during the period 1990-2001 shows a disinflation process that has produced the convergence of both the inflation rate and the real interest rate towards stationary levels (Figure 4).

All the equations in the system are simultaneously estimated and the results of this baseline model are contained in Table 5. All the coefficients have the expected sign, and are statistically significant. For the inflation equation, the estimated coefficient $\delta_\pi = 0.47$ with a standard error of 0.0046, suggests that 47% of current inflation responds to inflation inertia, and 53% corresponds to a forward-looking component. The estimate of $\delta_y = 0.0088$ with a standard error of 0.003 suggests that an increase in the output gap imposes some inflationary pressure. In addition, the estimated for the coefficient for real exchange rate $\delta_q = 0.051$ with a standard error of 0.0038 affects positively inflation. An increase in the real exchange rate of 1% (a depreciation) will increase inflation by 5 basis points.

In the case of the aggregate spending equation, some positive serial correlation remains in the residuals due to significant autocorrelation on the IMACEC at lag 12. Considering the two lags of output included in the equation, their estimators follow the traditional stationarity conditions. The estimates in the aggregate expenditure equation are all significant with the expected signs. The estimate of $\alpha_r = 0.0021$ with a standard error of 0.0002 implies that an increase in the long-term interest rates (lending rates) by 1% is going to affect the output gap by an estimated 0.2 basis points. In addition, the estimate of $\alpha_q = 0.01331$ with a standard

error of 0.0008 means that a real depreciation of 1% will stimulates aggregate spending by shifting domestic consumption of foreign goods to domestically produced goods, increasing output gap 1.3 basis points.

The coefficient that measures the degree of smoothness in the interest rate rule, ρ, is highly significant and close to one, showing a commitment from monetary authorities to gradually adjust interests to a stationary level. Its estimated value, 0.87 and a standard error of 0.002, partially explains the long period to converge to a stationary inflation rate. The most important estimator is $\beta_\pi = 0.1629$ with a standard error of 0.0207. A rise in future expected inflation above its target of 1% induces the Chilean authority to increase its real monetary policy rate by 16 basis points. The estimated coefficient for the reaction to future output gap, $\beta_y = 0.2982$ and a standard deviation of 0.0185, suggests that the authority reacts to deviations in the forecast output gap. A rise of expected future output above target of 1% induces the policy maker to increase the monetary policy rate by 29 basis points. Finally, the estimate of $\beta_{\overline{q}} : 0.137$ and a standard deviation of 0.0138 suggests that a nominal depreciation of the exchange rate between two periods equal to 1% induces the authority to increase the policy rate by 13 basis points. These results show an active policy making that reacts to deviations of future expected output and inflation from their targets, respectively, and also to changes in the nominal exchange rate.

In addition, the monetary policy rule allows for the calculation of the long-run real interest rate. For the period under consideration, it is equal to 6.55%, which is high considering the interest rate and inflation levels reached at the end of the sample, but consistent with the values of both variables at the beginning of the sample.

On Figure 5 I show the actual monetary policy rates versus the estimated values from the model. It is clear that the model characterizes the behavior of the monetary reaction function properly, partially as a consequence of the high inertia in interest rates.

The calculated J-statistic value is 23.77 with a $p - value$ of 0.999, which allows me to accept the overidentifying restrictions of the model (Hansen 1982).

Two robustness checks are proposed here. In the first one, instead of using the Index of Economic Activity (IMACEC) as a proxy of output, I use unemployment rate. The results are included in Table 6, which do not change substantially the statistic significance of the coefficients. As expected, there is a change in the sign of the coefficients δ_y, α_r, α_q, and β_y[31]. It is interesting the new monetary policy rate estimation. The estimate of the monetary reaction to inflation, $\beta_y = -1.5786$ with standard deviation of 0.0384, indicates that an increase of unemployment rate of 1% above the target value induces the monetary authority to reduce the monetary policy rate by 157 basis points or 1.57%. The coefficient that measures the reaction to inflation, $\beta_\pi = 0.5104$ and a standard error of 0.0282, suggests that a rise in future expected inflation above its target of 1% induces the Chilean authority to increase its real monetary policy rate by 51 basis points. The calculated J-statistic value is 24.12 with a $p - value$ of 0.999, which allows me to accept the overidentifying restrictions of this variation to the baseline model.

In the second robustness check, I consider different targeting horizons. Instead of using $k = q = 12$ in the monetary policy rule, I include one term targeting horizon. In this way, setting $k = q = 6$, the model estimates the reaction of the monetary authority to deviations

[31] There is a negative correlation between unemployment rate and the value of the IMACEC.

of 6-months forecast of inflation and output from their targets, and also changes in the nominal exchange rate. The results are included in Table 7 and are again similar to the ones from the baseline model.

7 A Credibility Enhancing Mechanism

The adoption of a predetermined inflation target represents a fundamental change in the way monetary policy is carried out in a particular country. After being implemented, its success will be determined by the credibility of the policy shift. If the public believes that the authorities' preferences have changed, and that they are committed to maintain the new framework, inflationary inertia is likely to decline. On the other hand, if the public believes that the authorities change in preferences is weak or simply false, inflationary inertia will not change.[32]

Consider a definition for the dynamics of inflation like the one described in Equation 2 in Section 5. This reduction in inflation inertia will be evident by a decrease in the lagged inflation coefficient, δ_π. The speed of this change will be a function of how fast the authority gains credibility by meeting its targets. Higher gains in credibility will be followed by faster reductions of the lagged inflation coefficient, while lower credibility gains will be followed by slower reductions of the coefficient.

In the Chilean case, as I mentioned in Section 4, indexation of public and private contracts was common in the economy, not only in the financial market due to the generalized use of

[32] Edwards (1996) followed this approach for countries adopting exchange-rate-based stabilization programs. In particular he estimated inflation-dynamic equations for Chile and Mexico when the nominal-exchange-rate anchor was adopted in February 1978 and February 1988, respectively.

real interest rates (see Page 17), but also and most importantly in the labor market. This fact constrained the reduction in inflation since lagged values of inflation had inevitably a high weight in the way contemporaneous inflation was formed, regardless of expectations about future prices. This implies that a reduction in the lagged inflation coefficient estimated in the model, if any, will undervalue the real gain in credibility in the monetary authorities because the agent's ability to adapt their expectations is constrained by the institutionalized inertia.

In order to analyze the evolution of the coefficient δ_π during the sample period, I re-estimated the model described in Section 5 for a moving sample of fifty nine periods, starting with the sample September 1990-July 1995 and ending with the sample October 1995-August 2000. As a new period entered in the sample, the oldest observation was removed from it. Figure 6 shows the value of the coefficient δ_π, where the month in the horizontal axis is the last month of each sample included in each sample. Although the evolution of δ_π is not smooth, it shows a decreasing trend. A simple OLS regression reveals a negative slope that is statistically significant at standard confidence levels (Table 8).

Using the measure of credibility suggested here, it appears that the monetary authority, although modestly, gained credibility after inflation targeting was set in place. These results also allow me to affirm that a higher degree of credibility in the monetary authorities contributed to the reduction in inflation, since the weight of lagged inflation in the inflation dynamics equation decreased. It was expectable that the most successful[33] central bank targeting inflation among emerging market countries would have gained a higher degree of

[33]See Section 3 in page and Table 3 for details.

credibility at home.

8 Conclusions

In this work I described inflation targeting and analyzed the inflation performance among the countries that implemented this framework, which are a majority of emerging market countries. Then I estimated a simple rational-expectations structural model for Chile, the first emerging market economy to implement inflation targeting. My model contains only four equations and seventeen variables, but carries a considerable theoretical content and provides a stylized representation of the monetary policy transmission mechanism.

The equations in the system are simultaneously estimated. All of the coefficients have the expected sign, and are statistically significant. The results are robust for different measures of output, and for different targeting horizons. The evidence provided shows that the Chilean economy was more forward-looking than backward-looking, but still a high degree of inflation inertia was present during the sample period, which in turn explains the length of the disinflation process towards a stationary level. The evidence presented also suggests that inflation targeting enhanced central bank credibility in Chile, a factor that contributed to the reduction of inflation, although high institutionalized inertia undermine its impact.

In terms of policymaking, the authority has not reacted only to deviations of expected future inflation from its announced target, but also to deviations of output from its target, and changes in the nominal exchange rate. The estimation results characterize the behavior of the monetary reaction function properly.

Inflation targeting, when implemented properly, appears to be delivering a solid monetary framework for both industrialized and emerging market economies. It increases transparency and coherency of policy, at the same time that it provides some discretion for dealing with short-run volatility. Although some countries have been more successful than others in targeting inflation, every country that adopted this framework is still using it, and more and more countries move in the same direction.

Bibliography

Agénor Pierre-Richard (2001), " Monetary Policy Under Flexible Exchange Rates: An Introduction To Inflation Targeting", Central Bank of Chile Working Paper No. 105.

Amato Jeffery and Stefan Gerlach (2002), "Inflation targeting in emerging market and transition economies: Lessons after one decade", *European Economic Review* 46 781-790.

Ball Laurence (1999). Policy Rules for Open Economies. In *Monetary Policy Rules*, ed. John Taylor. Chicago, National Bureau of Economic Research.

Ball Laurence and Niamh Sheridan (2003), "Does Inflation Targeting Matters?", Conference on "Inflation Targeting", NBER

Barro Robert and David B. Gordon (1983). "A Positive Theory of Monetary Policy in a Natural Rate Model". *The Journal of Political Economy*, Vol. 91, No. 4. pp. 589-610.

Batini Nicoletta and Andrew Haldane (1999). Forward-Looking Rules for Monetary Policy. In *Monetary Policy Rules*, ed. John Taylor. Chicago, National Bureau of Economic Research.

Batini Nicoletta, Harrison Richard and Stephen Millard (2001). Monetary Policy Rules for an Open Economy. Working Papers. Bank of England.

Bernanke Ben, Thomas Laubach, Frederic Mishkin and Adam Posen (1999). *Inflation Targeting, Lessons form the International Experience*, Princeton University Press

Bernanke Ben and Frederic Mishkin (1997). "Inflation Targeting: A New Framework for Monetary Policy?". *Journal of Economic Perspectives.* Vol. 11, No. 2. pp. 97-116

Bernanke Ben and Michael Woodford (1997). "Inflation Forecasts and Monetary Policy". *Journal of Money, Credit, and Banking.* Vol. 29, No. 4. pp. 653-684

Bogdanski, J., P. Springer, I. Goldfjan, and A. Tombini (2002). "Inflation Targeting in Brazil: Shocks, Backward-Looking Prices and IMF Conditionality." In *Inflation Targeting: Design, Performance, Challenges*, edited by N. Loayza and R. Soto. Santiago: Central Bank of Chile.

Bowen Alexander, (1995), British experience with inflation targeting, In: Leonardo Leiderman and Lars E.O. Svensson, Ed. *Inflation targets* (CEPR, London)

Bruno, Michael (1978). "Exchange Rates, Import Costs, and Wage-Price Dynamics", *Journal of Political Economy* 86, June, pp. 379-403.

Calvo, Guillermo (1983). "Staggered prices in a utility-maximizing framework". *Journal of Monetary Economics* 12, 383–398.

Carare, A., A. Schaechter, M. Stone, and M. Zelmer (2002). "Establishing Initial Conditions in Support of Inflation Targeting." Working Paper No. 02/102: International Monetary Fund.

Cecchetti, S. and M. Ehrmann (2002). "Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers Preferences and Outcomes", in

Klaus Schmidt-Hebbel, ed. *Monetary Policy: Rules and Transmission Mechanisms*, Proceedings of the Third Annual Conference of the Central Bank of Chile.

Clarida Richard, Gali Jordi and Mark Gertler (2000). "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory". *The Quarterly Journal of Economics.* February 2000.

Corbo, Vitorio (1985). "International Prices, Wages and Inflation in Open Economy", *Review of Economics and Statistics* 67: 564-573.

———— **(1998).** "Reaching One-Digit Inflation: The Chilean Experience". *Journal of Applied Economics*, Vol. I, No. 1. pp. 123-163

Corbo Vitorio and Klaus Schmidt-Hebel (2001). "Inflation Targeting in Latin America", Central Bank of Chile Working Paper No. 105.

Corbo Vitorio and Stanley Fisher (1994). "Lessons from the Chilean Stabilization and Recovery", en *The Chilean Economy: Policy Lessons and Challenges*, B. Bosworth et al. Ed. Washington D.C.: Brookings

Cushing Matthew and Mary McGarvey (2000). "Covariance Matrix Estimation", in Matyas Laszlo, ed., *Generalized Method of Moments Estimation,* Cambridge University Press. 63-95.

Debelle, G. And J. Wilkinson (2002). "Inflation Targeting and the Inflation Process: Lessons from an Open Economy." In Inflation Targeting: Design, Performance, Challenges, edited by N. Loayza and R. Soto. Santiago, Chile. Central Bank of Chile.

Drew, A. (2002). "Lessons from Inflation Targeting in New Zealand." In In Inflation Targeting: Design, Performance, Challenges, edited by N. Loayza and R. Soto. Santiago, Chile. Central Bank of Chile.

Edwards, Sebastian (1999). "Exchange-Rate Anchors, Credibility, and Inertia: A Tale of Two Crises, Chile and Mexico". *The American Economic Review*, Vol. 86, No. 2, 176-180.

Felipe Hector, Correa Victor, Luna Leonardo and Francisco Ruiz (2002). "Desestacionalizacion de Series Economicas: El procedimiento Usado por el Banco Central de Chile". Working Paper No. 177. Central Bank of Chile.

Filosa, Renato (2001). "Monetary Policy Rules in Some Mature Emerging Economies", Bank For International Settlements, Working Paper # 8

Fuentes R., Jara A., Schmidt-Hebbel K., Tapia M. and E. Arrnaño (2002). "Efectos de la Nominalización de la Polítca Monetaria en Chile". Working Paper No. 197. Central Bank of Chile.

Fuhrer, J. and G. Moore (1995a). "Monetary Policy Trade-offs and the Correlation Between Nominal Interest Rates and Real Output", *American Economic Review*, 85, no.1 (March): 219-239

———. **(1995b).** "Inflation Persistence." *Quarterly Journal of Economics*, 110, no.1 (February): 127-159

Hamilton James. (1994) *Time Series Analysis.* Princeton University Press, New Jersey.

Hansen, L.P. (1982). "Large Sample Properties of Generalized Methods of Moments Estimators". *Econometrica* 50, 1029-1054

Johnson, David (2002). "The Effect of Inflation Targeting on the Behavior of Expected Inflation: Evidence from an 11 Country Panel". *Journal of Monetary Economics,* Vol. 49, 1521–1538

Jonas Jiri and Frederic Mishkin (2003). "Inflation Targeting in Transition Countries: Experience and Prospects," in Michael Woodford, ed., *Inflation Targeting* (University of Chicago Press: Chicago, forthcoming.)

Landerretche Oscar, Morandé Felipe and Klaus Schmidt-Hebbel (1999). "Inflation Targets and Stabilization in Chile", Central Bank of Chile, Working Paper #55, December 1999

Laubach Thomas and Adam Posen (1997). "Some Comparative Evidence on the Efectiveness of Inflation Targeting", Federal Reserve Bank of New York, Research Paper # 9714.

Mishkin Frederic (1999). "International Experiences with Different Monetary Policy Regimes," *Journal of Monetary Economics*, Vol. 43, #3 (June 1999): 579-606

Mishkin Frederic and Klaus Schmidt-Hebbel (2001). "One Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know?" in Norman

Loayza and Raimundo Soto, eds., *Inflation Targeting: Design, Performance, Challenges* (Central Bank of Chile: Santiago 2001): 117-219.

Mishkin Frederic and Miguel Savastano (2001). "Monetary Policy Strategies for Latin America," *Journal of Development Economics*, 66: 415-444

Mittelhammer Ron, George Fudge and Douglas Miller (2000). *Econometric Foundations*, Cambridge University Press, USA.

Morandé, Felipe and Klaus Schmidt-Hebbel (1999). "Monetary Policy and Inflation Targeting in Chile", Working Paper, Central Bank of Chile.

Neely, Christopher J. (1994) "A Reconsideration of the Properties of the Generalized Method of Moments in Asset Pricing Models", Working Paper 1994-010A, Federal Reserve Bank of Saint Louis.

Newey, W. and K. West (1987). "A simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix". *Econometrica*, Vol. 55, pp. 703-708

Priestly, M.B. (1981). *Spectral Analysis and Time Series*; Volumes I and II. Academic Press. London

Schaechter, A., M. Stone, and M. Zelmer (2000). "Adopting Inflation Targeting: Practical Issues for Emerging Market Countries." Occasional Paper 202. International Monetary Fund.

Schmidt-Hebbel Klaus and Matias Tapia (2002a). "Inflation Targeting in Chile". *North American Journal of Economics and Finance*, Vol. 13, 125-146

Schmidt-Hebbel Klaus and Matias Tapia (2002b). "Monetary Policy Implementation and Results in Twenty Inflation-Targeting Countries". Working Paper # 166. Central Bank of Chile.

Soto Claudio and Rodrigo Valdes (1999). "Exchange Rate Volatility and Risk Premium". Central Bank of Chile. Working Paper 46.

Sterne, G. (2002). "Inflation Targets in a Global Context." In *Inflation Targeting: Design,Performance, Challenges*, edited by N. Loayza and R. Soto. Santiago: Central Bank of Chile.

Svensson, Lars (1993). "Discretion versus policy rules in practice. Carnegie-Rochester Conference Series on Public Policy 39:195-214

——— **(1997a).** "Inflation forecast targeting: Implementing and monitoring inflation targets." *European Economic Review*, 41, 1111-1146.

——— **(1997b).** "Inflation Targeting: Some extensions" National Bureau of Economic Research. Working paper No. 5962

——— **(2000).** "Open-economy inflation targeting." *Journal of International Economics*, 50, 155-183

Taylor, John (1980). "Aggregate Dynamics and Staggered Contracts." *Journal of Political Economy*, 88 (1), 1-24

——— **(1993).** "Discretion versus policy rules in practice". Carnegie-Rochester Conference Series in Public Policy 39, 195-214.

Valdes, Rodrigo (2003). "MEP 1-Structural Macroeconomic Model for Chile: An Overview". Monetary Policy: Shocks and Effectiveness Conference organized by the Central Bank of Brazil.

Walsh Carl (2000). *Monetary Theory and Policy*, MIT Press.

White, H. (1980). "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity". *Econometrica*, Vol.48, pp. 817-838

TABLE 1

INFLATION PERFORMANCE AMONG TARGETERS

INDUSTRALIZED	(I) 1980-1989	(II) 1990-2002	(III) Before IT	(IV) After IT	(V) $t-4$	(VI) $t+4$	(VII) Change
Australia	8.4	2.8	6.8	2.7	2.2	5.1	2.9
Canada	6.5	2.3	6.4	2.1	5.4	1.6	-3.8
New Zealand	11.9	2.3	11.9	2.3	4.0	4.5	0.5
Sweden	7.9	3.0	11.9	1.9	3.3	1.7	-1.6
Finland	7.3	2.2	16.6	1.2	2.8	0.3	-2.5
Spain	10.3	4.0	8.8	3.3	4.8	4.4	-0.4
United Kingdom	7.5	3.3	7.3	2.7	4.2	1.6	-2.6
Norway	8.3	2.4	5.3	2.0	2.9	0.4	-2.5
Switzerland	3.2	2.1	2.8	1.1	1.0	0.9	-0.2
Average	7.9	2.7	7.5	2.1	3.4	2.3	-1.1
EMERGING							
Chile	21.5	9.8	21.9	8.5	23.4	18.7	-4.7
Israel	132.2	8.8	113.2	7.1	17.9	10.8	-7.1
Czech Republic		6.6	9.1	4.7	7.1	3.0	-4.2
Brazil	318.3	350.3	702.6	7.4	3.7	6.6	2.8
Poland	141.1	14.8	126.0	6.4	13.5	9.3	-4.2
South Africa	13.8	7.4	12.3	6.9	14.7	6.4	-8.4
Thailand	4.6	3.8	5.4	1.3	-0.4	2.5	2.9
Colombia	27.0	15.2	23.0	8.0	19.0	8.0	-11.0
Korea	6.4	4.2	7.4	3.5	4.7	0.7	-4.0
Mexico	72.9	16.8	46.7	9.4	15.3	7.5	-7.8
Peru	2245.6	8.0	940.8	8.0	55.3	12.9	-42.5
Average*	34.8	9.1	29.9	8.2	15.9	7.8	-8.0

* Brazil (318.3% and 350.3%), Poland (141.2% and 14.8%) and Peru (2245.6% and 8%) are excluded from the group of emerging countries for this calculation because of the high inflation rates. Including them, the average inflation for both periods considered are 298.3% and 40.5%, respectively.

Source: Countries' central banks and statistical offices - Haver Analytics

TABLE 2

INFLATION VOLATILITY AMONG TARGETERS

INDUSTRALIZED	(I) 1980-1989	(II) 1990-2002	(III) Before IT	(IV) After IT	(V) = (IV)-(III) Change in Volatility
Australia	0.26	0.74	0.50	0.68	018
Canada	0.49	0.67	0.49	0.67	0.18
New Zealand	0.43	0.71	0.43	0.71	0.27
Sweden	0.39	1.12	0.43	0.85	0.42
Finland	0.41	0.715	0.46	0.58	-0.12
Spain	0.37	0.39	0.44	0.37	-0.07
United Kingdom	0.60	0.67	0.57	0.27	-0.30
Norway	0.35	0.37	0.68	0.59	-0.09
Switzerland	0.56	0.96	0.72	0.47	-0.25
Average	0.43	0.70	0.53	0.58	0.05
EMERGING					
Chile	0.39	0.75	0.37	0.69	0.32
Israel	0.95	0.73	1.08	0.76	-0.32
Czech Republic		0.53	0.12	0.77	
Brazil	1.15	3.98	1.68	0.17	-1.51
Poland	1.21	15.65	2.05	0.51	-1.54
South Africa	0.16	0.51	0.31	0.52	0.21
Thailand	1.26	0.66	0.82	0.56	-0.27
Colombia	0.15	0.52	0.21	0.16	-0.05
Korea	1.40	0.60	0.93	0.70	-0.23
Mexico	0.57	0.65	0.85	0.60	-0.34
Peru	0.54	236.53	2.14	0.91	-1.23
Average	0.78	23.74	0.96	0.57	-0.39

Source: Countries' central banks and statistical offices - Haver Analytics

TABLE 3
INFLATION TARGETING PERFORMANCE AMONG EMERGING COUNTRIES

	(I) Starting Date	(II) Absolute Deviation (%)	(III) Absolute Deviation (%) Standarized	(IV) Frequency Periods >1%	of Deviation (% months.) <-1%	Average of Deviation >1%	(V) Duration Periods (mo.) <-1%
Brazil	Jun-1999	4.14	0.88	60	15	12	9
Chile	Sep-1990	1.13	0.16	19	18	4	4
Colombia	Sep-1999	2.08	0.20	17	49	6	16
Korea	Jan-1998	1.90	0.45	20	19	5	11
Israel	Dec-1991	2.42	0.47	31	44	6	13
Mexico	Jan-1999	1.78	0.22	27	44	4	28
Peru	Jan-1994	2.12	0.32	17	47	4	12
Poland	Oct-1998	2.85	0.46	35	52	13	20
Czheq Republic	Jan-1998	2.59	0.54	26	47	9	16
South Africa	Feb-2000	2.79	0.62	58	16	15	4
Thailand	Apr-2000	1.15	0.66	22	37	6	6
Average		2.27	0.45	30	35	8	13

Source: Countries' central banks and statistical offices - Central Bank of Chile. Informe Monetario Septiembre 2004

TABLE 4

LATIN AMERICAN COUNTRIES OPPENESS

	Total Exports (millions US$)	Nominal GDP (millions US$)	Exports/Nominal GDP (%)
Brazil	73,084	460,118	15.88
Argentina	29,375	100,956	29.10
Venezuela*	25,750	85,619	30.08
Colombia	12,695	81,201	15.63
Chile	21,045	72,054	29.21
Peru	8,984	61,039	14.72
Ecuador	6,038	26,844	22.49
Guatemala	4,459	24,732	18.03
Costa Rica***	6,110	17,476	34.96
Dominican Republic**	5,439	15,324	35.50
El Salvador**	3,069	14,996	20.46
Panama	808	12,888	6.27
Uruguay	2,198	11,191	19.64

* Oil represented 84% of total exports in Venezuela, 90% of which goes to the U.S.
** Includes total value of maquila exports and not only the added value
*** Includes total exports of Intel-Costa Rica of $1.6 billion in 2003

Source: Global Insight Inc.

TABLE 5

BASELINE ESTIMATES

Equation/Parameter	Estimate
Inflation Equation	
δ_π	0.4687 (0.0046)
δ_y	0.0088 (0.003)
δ_q	0.0509 (0.00375)
Aggregate Spending	
α_1	1.7863 (0.0034)
α_2	−0.8278 (0.0038)
α_r	0.0021 (0.0002)
α_q	0.01331 (0.0008)
Monetary Policy	
β_π	0.1629 (0.0207)
β_y	0.2982 (0.0185)
$\beta_{\bar{q}}$	0.1370 (0.0138)
ρ	0.8737 (0.0019)
r	6.5508 (0.0233)
J-Statistic=23.76	**Prob=0.9999 DF=95**

TABLE 6

UNEMPLOYMENT AS PROXY FOR OUTPUT

Equation/Parameter	Estimate
Inflation Equation	
δ_π	0.4799 (0.00655)
δ_y	−0.0299 (0.0029)
δ_q	0.07526 (0.0046)
Aggregate Spending	
α_1	1.7530 (0.0032)
α_2	−0.7977 (0.0031)
α_r	−0.0021 (0.0000)
α_q	−0.0129 (0.0006)
Monetary Policy	
β_π	0.5104 (0.0282)
β_y	−1.5786 (0.0384)
$\beta_{\overline{q}}$	0.6014 (0.0237)
ρ	0.8841 (0.0018)
r	6.9817 (0.0371)

J-Statistic=24.12 Prob=0.9999 DF=95

TABLE 7

SHORTER TARGETING $k = q = 6$

Equation/Parameter	Estimate
Inflation Equation	
δ_π	0.4699 (0.0046)
δ_y	0.0088 (0.0032)
δ_q	0.0511 (0.0035)
Aggregate Spending	
α_1	1.7853 (0.0026)
α_2	−0.8265 (0.0031)
α_r	0.0021 (0.0001)
α_q	0.0133 (0.0008)
Monetary Policy	
β_π	0.4372 (0.0178)
β_y	0.3323 (0.0178)
$\beta_{\overline{q}}$	0.1751 (0.0190)
ρ	0.8653 (0.0036)
r	6.7251 (0.0165)

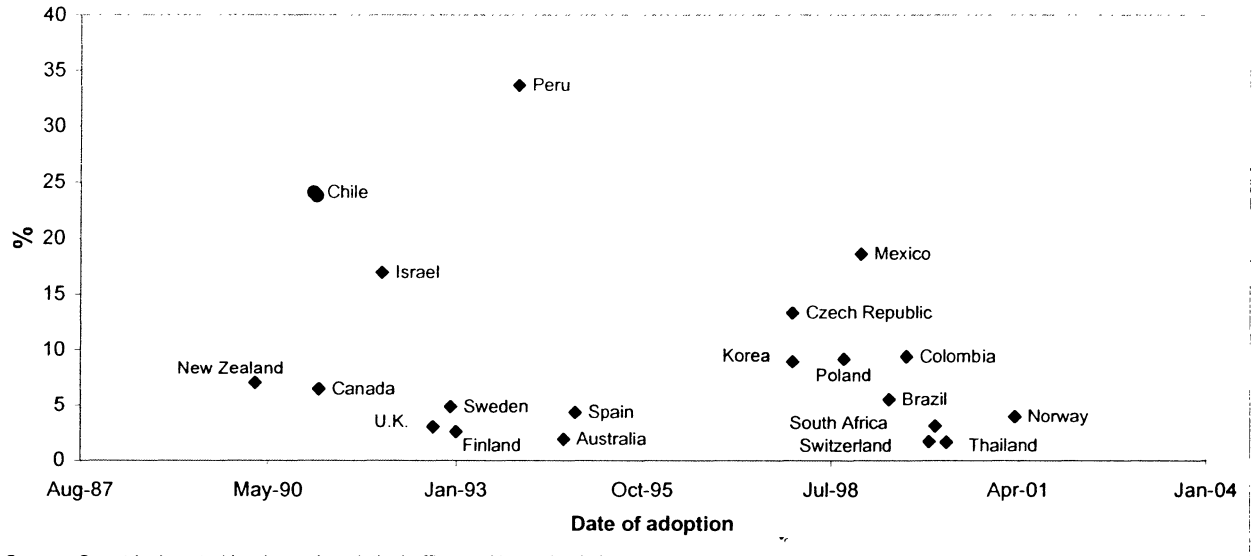
J-Statistic=23.96 Prob=0.9999 DF=95

TABLE 8
LAGGED COEFFICIENT VALUE

	df	SS	MS	F	Significance F
Regression	1	0.000893	0.000893	32.0382	4.7E-07
Residual	59	0.001644	2.79E-05		
Total	60	0.002537			

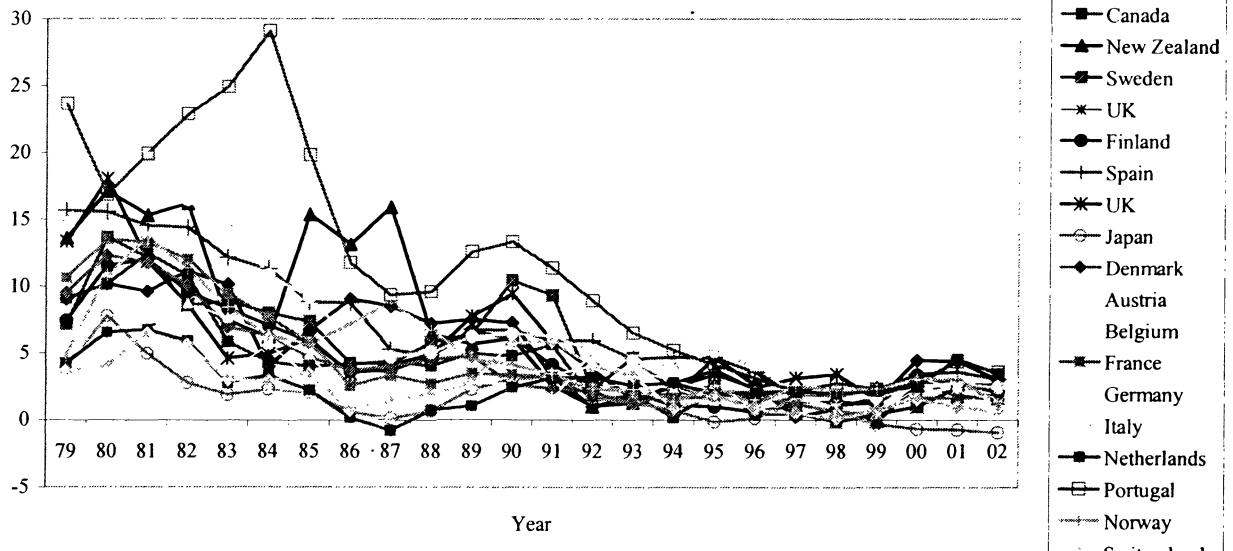
	Coefficient	Standard Error	t Stat	P-value
Intercept	0.4825	0.001402	344.1855	3.8E-99
Time	-0.00022	3.84E-05	-5.66024	4.7E-07

Figure 1
Consumer Price Inflation at Time of Adoption



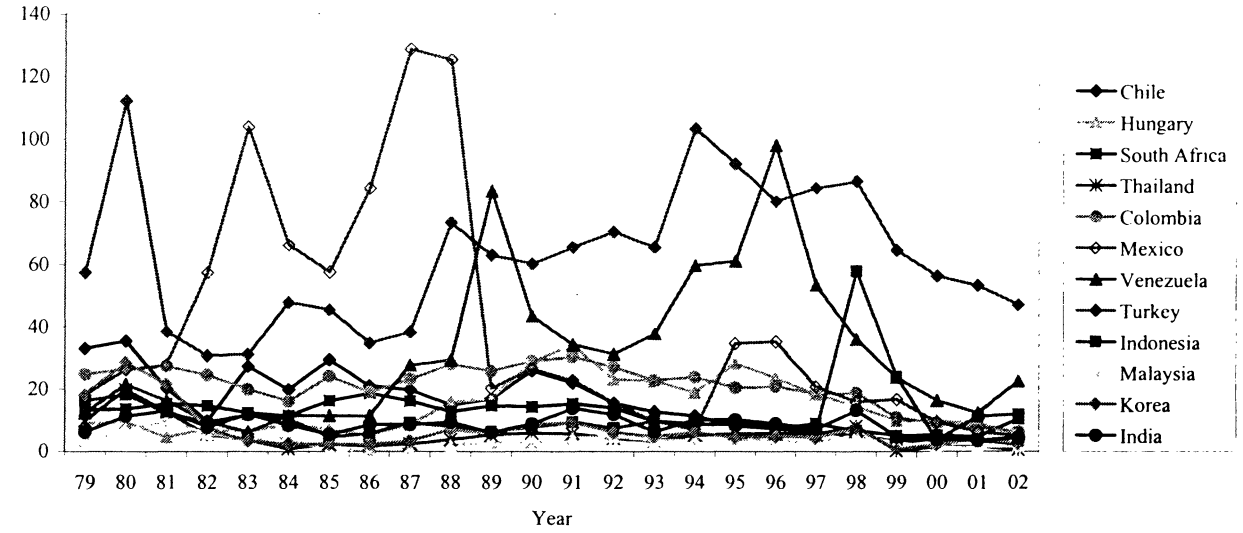
Source: Countries' central banks and statistical offices - Haver Analytics

Figure 2
Industrialized Countries - Anual Inflation %



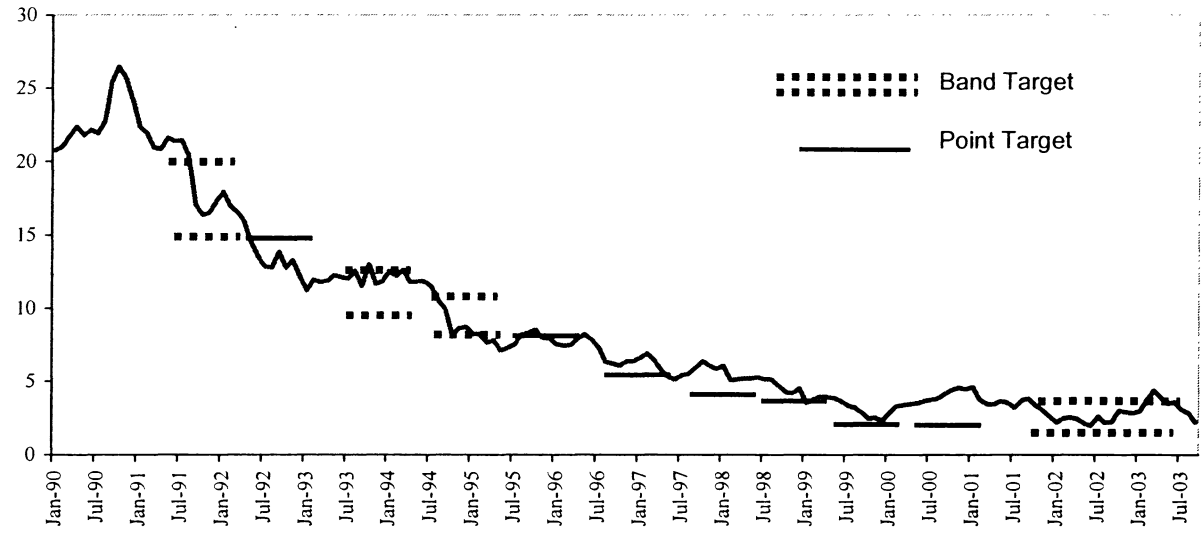
Source: Countries' central banks and statistical offices - Haver Analytics

Figure 3
Emerging Countries - Anual Inflation (%)



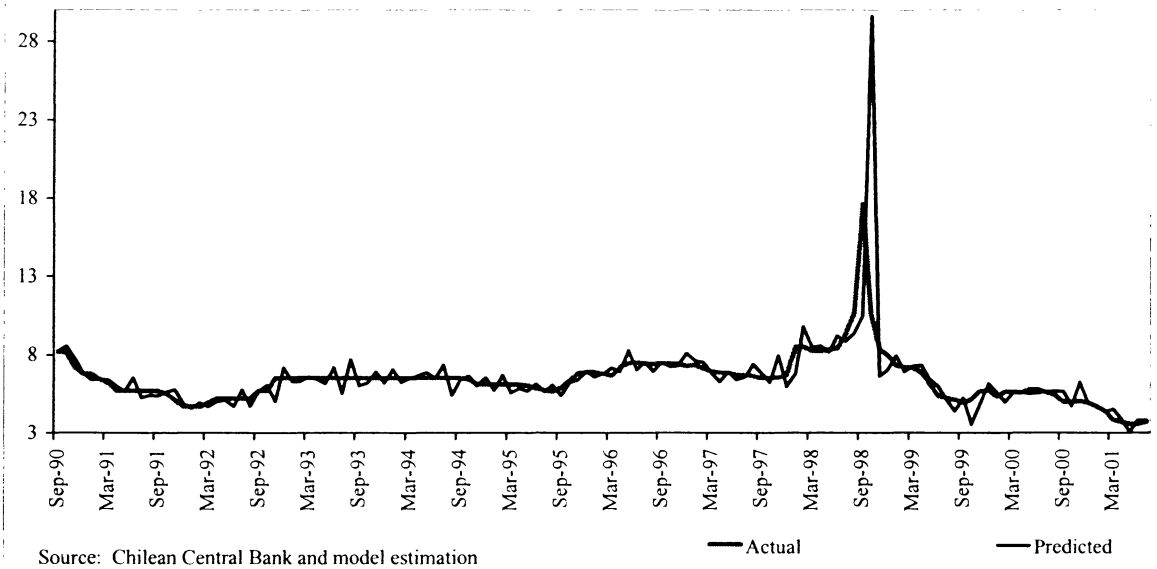
Source: Countries' central banks and statistical offices - Haver Analytics

Figure 4
Consumer Inflation and Announced Targets (%)



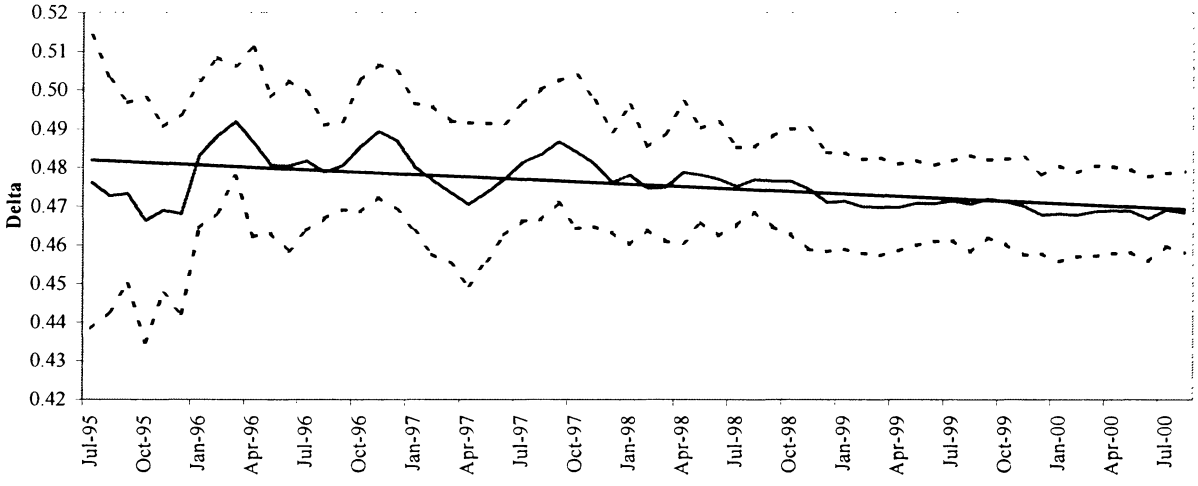
Source: International Financial Statistics - Chilean Central Bank

Figure 5
Estimated vs. Actual Monetary Policy Rate (%)



Source: Chilean Central Bank and model estimation

Figure 6
Lagged Inflation Coefficient - Moving Sample



Final Month of the Sample (59 months included in the estimation of each datapoint)

Source: Model estimation

Window sample estimation +/- 2 SE

Santiago Mosquera

BA Pontificia Universidad Católica del Ecuador, 1998

The Chilean Experience with Inflation Targeting

Directed by Bartholomew Moore, PhD

Empirical studies have concentrated on testing the effectiveness of inflation targeting in industrialized economies, perhaps because of their longer experience and better data availability. However, more than half of the countries now targeting inflation are emerging market economies. The performance of inflation targeting in these countries has not been sufficiently studied. Using Generalized Method of Moments, I estimate a structural small-open-economy model of Chile, the country with the longest experience of inflation targeting and an emerging market economy. I find that the monetary authority has targeted not only inflation but also output and the exchange rate. The finding indicates that inflation has been more forward looking than backward looking. Still a high degree of inflation inertia was present during the sample period. In addition, I found that inflation targeting has been a credibility enhancing mechanism in Chile, measuring credibility by the reduction of inflation inertia after the framework was set in place in 1990.

VITA

Santiago Felipe Mosquera, son of Benjamin and Marcela Mosquera, was born on October 13, 1974, in Quito, Ecuador. After graduating in 1992 from Intisana High School in Quito he entered Pontificia Universidad Catolica del Ecuador. In 1998, he received the Bachelor of Arts degree in Economics.

Prior to beginning his graduate studies in the United States, he worked for five years in the Ecuadorian financial industry. He was a fixed income portfolio manager and stockbroker agent at the Quito Stock Exchange for the Grupo Financiero Produccion (Produbanco), in particular, for Produvalores, its team-oriented brokerage division. In addition, he managed the alliance between Produbanco and CIBC Oppenheimer, a division of the Canadian Imperial Bank of Commerce.

Thanks to a Fulbright Scholarship he was awarded in Ecuador, he entered Fordham University in 2000. During his time at Fordham, he was also awarded a Presidential Scholarship, a Barsa Scholarship, and a University Fellowship. While working toward his doctoral degree in Economics, under the mentorship of Dr. Bartholomew Moore, he served as an adjunct professor in the Department of Economics teaching Microeconomis and Macroeconomics.

Currently, he is an economist in the Latin America Service of Global Insight, an American consulting firm resulting from the merger between Wharton Economic Forecast Associates (WEFA) and Data Resources Inc. (DRI). He is responsible for the macroeconomic forecasts, the political context analysis, and the risk-scoring systems of Ecuador, Bolivia, Costa Rica, and Guatemala. He also contributes to the analysis of Mexico, El Salvador, and Honduras.