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INFLATION TARGETS AND STABILIZATION IN CHILE

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Resumen

Chile estuvo entre los primeros países en adoptar una meta de inflación. Su largo historial inflacionario había llevado a una indexación extendida en los mercados de bienes, trabajo y financiero, así como en los instrumentos de política. Pese a la exacerbación de la inercia inflacionaria que provoca la indexación, este trabajo muestra evidencia de cómo la adopción de metas inflacionarias por parte de un Banco Central autónomo a partir de 1990 ha provocado un cambio de régimen que se refleja en una convergencia gradual de la inflación hacia niveles internacionales. Evaluar la experiencia chilena en el contexto internacional y analizar la conducción de la política monetaria en Chile entrega los fundamentos para entender su reciente experiencia estabilizadora. Un modelo dinámico simple ilustra el rol y los efectos macro de las metas de inflación en una economía abierta y altamente indexada. Estimaciones con VARs para inflación, metas de inflación y variables macro relacionadas apoyan la noción de que la introducción de metas inflacionarias *"forward-looking"* han ayudado a romper las expectativas de inflación, permitiendo así la convergencia de Chile a nivel sostenidamente bajo de inflación y a reducir la influencia de la indexación, pese a que muchos de los mecanismos de indexación aún permanecen.

Abstract

Chile was among the first countries to adopt an inflation target. Its long inflation history had led to widespread backward-looking indexation in goods, labour, and financial markets as well as in policy instruments. While indexation exacerbates inflation inertia, this paper provides evidence that adoption of inflation targets by an autonomous Central Bank since 1990 has made possible a regime change reflected in gradual inflation convergence toward international levels. Assessing Chile's targeting experience in an international context and analyzing the conduct of monetary policy in Chile provides the background for understanding its recent stabilization experience. A simple dynamic model illustrates the role and macro effects of inflation targeting in a highly indexed open economy. VAR estimations for inflation, inflation targets, and related macro variables support the notion that the introduction of forward-looking inflation targets has contributed to breaking inflation expectations, paving the way for Chile's convergence to sustained lower inflation and reducing the influence of indexation albeit most indexation mechanisms are still in place.

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1. Introduction

Chile's stabilization experience is quite unique among countries that have adopted inflation targets for three reasons. First the Chilean economy appears to be one of the most indexed in the world; backward indexation mechanisms are widespread in many non-traded goods, labour, and financial markets. Even policy instruments are indexed, including income taxes and the monetary policy interest rate.[i] Second, and to a large extent in response to indexation, Chile's program of price stabilization has been the world's most gradualist. Inflation has been brought down step by step – almost monotonically – from 24% in 1990 to close to 3.0% in 1999. Third, Chile was among the first countries to adopt a monetary framework based on an explicit publicly announced annual inflation target. The first target was announced September 1990 for the subsequent calendar year 1991. The (by then only recently independent) Central Bank of Chile (CBC) adopted the target at a time when annual inflation was around 25%, a figure that had been approximately stationary during the 1980s. Therefore Chile was among the very few countries (Israel being another case) to adopt an inflation targeting at an inflation level that exceeded by 20 percentage points its long-term inflation goal. This stands in stark contrast to most other (industrialized) countries that adopted targets when they were close to low stationary inflation levels.

A major reason for Chile's early adoption of an inflation target was the notion that providing the public with an explicit inflation objective – and committing to its attainment by adopting a supportive monetary policy – would reduce the extent of indexation mechanisms, hence reducing the cost of stabilization. This paper analyzes the features, role, and macroeconomic consequences of inflation targeting in Chile, taking into account the specific conduct of monetary policy in an open economy characterized by strong indexation.

Section 2 describes Chile's experience with inflation targeting, comparing it to inflation targeting in other countries. Section 3 reviews the conduct of monetary policy and monetary transmission mechanisms. The stabilization experience of the 1990s is

discussed in section 4. A simple structural model for a small open economy with inflation inertia stemming from indexation is developed next to illustrate the dynamic effects of an inflation target on the main macroeconomic variables. Inflation forecasts from VAR estimations for inflation, the inflation target, and related macro variables in Chile suggest are used in section 6 to analyze the role of inflation targeting in breaking inflation expectations. A final section concludes briefly.

2. Inflation targeting: Chile's experience in international comparison

A growing number of countries have adopted explicit inflation targeting as their monetary framework during the 1990s (Table 1). New Zealand (1988), Canada (1991), the United Kingdom (1992), Sweden (1993), and Australia (1993) were the first industrial countries to adopt inflation targets. Among developing countries, Colombia (1991), and Israel (1991) were early inflation targeters. [ii] The Central Bank of Chile was one of the first central banks in the world – in September 1990 – to adopt an explicit and publicly announced annual inflation target (See Table 1). After obtaining its independence in 1990, the CBC had to face a substantial inflation shock caused by expansionary policies adopted in 1989 and the effects of the temporary oil price shock associated to the 1990 Gulf War. In this context the Bank simultaneously tightened monetary policy and decided to adopt an inflation target as the nominal anchor for the economy and the conduct of its monetary policy.

Inflation targeting along the transition path toward low inflation is markedly different from when inflation is close to its stationary level. Table 1 distinguishes two groups of countries that use inflation targets. The top part of the table comprises Chile and Israel, two countries whose initial targets were around 15% far the inflation rates they eventually attained. Their experience contrasts starkly to that of the five industrial countries included in the bottom part of the table. These countries were much closer to low, stationary inflation rates at the time of adopting inflation targeting. Specific design

and implementation features of inflation targeting also differ among converging-inflation and stationary-inflation targeters, as discussed next.

Target inflation measure.

The inflation target can be defined on the variation of headline CPI variation or on a measure of underlying or core inflation. The headline CPI is a more comprehensive measure of the cost of living index. It is also more widely understood, thus increasing its communicational effectiveness. In countries with significant price and wage indexation, such as Chile and Israel, the (lagged) headline CPI is used as the relevant index. However, headline CPI inflation is much more volatile than any measure of core inflation, and may therefore provide less information content than core inflation for the conduct of monetary policy. In converging-inflation countries with high indexation like Chile and Israel, the above mentioned benefits dominate the costs of using headline CPI inflation- in contrast to most stationary inflation targeters where the inflation target is defined for core CPI measures that exclude volatile CPI items. This, by the use of a widely known and transparent indicator as an instrument to enhance credibility, a relevant issue in countries with a high inflation record.

Long-term target level.

Theory does not provide a precise answer to the question about the optimal rate of inflation, although it provides a list of potential costs and benefits of inflation. On the cost side – the "sand in the wheels" arguments – inflation raises relative price variability, overall uncertainty, financial and tax distortions, and transactions costs; all this reduces growth and welfare. On the benefit side – the "grease in the wheels" arguments – inflation may contribute to more flexible relative price adjustments when price rigidities are widespread.[iii] In addition, it is well established that official CPI inflation measures suffer from positive measurement bias (in comparison to a true welfare-based cost-of-living index) due to changes in product quality, product substitution, and other problems. Recent studies for industrial countries suggest that annual inflation is overestimated by 1%-1.5%.[iv] In practice, the weights given to the aforementioned costs, benefits, and measurement biases of inflation are imprecise. However, most OECD countries – with or

without inflation targets – have adopted stationary or long-term CPI inflation targets of 1 to 3% per year, typically slightly higher than their measurement of inflation bias. Chile has recently adopted a stationary annual inflation target range of 2%-4% (centered on 3%) for 2001 onwards.

Target band width.

The advantages of a target range include the lower likelihood of missing a narrow (point) target and the feasibility of accommodating small short-term shocks. The costs of a target range are the possibility of sending a less clear signal to the public and a weaker commitment with the lower part of the range, as well as being subject to stronger pressures from the government and the private sector to take larger inflation risks and to accommodate positive inflation shocks. In Chile target ranges were used both at the beginning and at the end of inflation convergence. In between, at moderately low but not stationary inflation levels yet, point targets were adopted to reduce the above mentioned pressures.

Target horizons.

Longer or unlimited target horizons are the rule in countries at steady-state inflation levels. When converging to low inflation, short (annual) horizons help to define a specific path of declining inflation. However, short target horizons may force central banks to overreact to price shocks in order to meet their targets at the cost of causing excessive output volatility, adding also to more variability of interest and exchange rates. The adoption of annual horizons in Chile during 1991-1999 may have contributed to greater volatility of the latter variables. However under current convergence to stationary inflation in the range of 2%-4% and lengthening of target horizon to an undefined horizon from 2001 onwards it is likely that relative volatility of output will decline at the cost of larger price volatility.

Escape clauses or exemptions.

It is unusual to modify a numerical inflation target during the time period horizon for which it has been defined. However most industrial-country targeters at stationary

inflation have an escape clause in the sense that deviations from latest are allowed as long as they are small and temporary. These exemptions are institutionalized and monitored more strictly in a few countries (New Zealand, Sweden, United Kingdom) where public statements or letters have to be issued by the corresponding central bank, providing an explanation of the target misses, spelling out corrective measures undertaking to return to the target point or range. Fewer converging economies have established exemptions, probably to avoid abuse of escape clauses and derived weakening of the targeting framework.

Convergence.

Industrial-country inflation targeters were close to stationary inflation when adopting targeting. Those that were somewhat above their long-run target levels converged quickly to the latter levels – it took them at most 1 to 2 years (New Zealand, United Kingdom). In converging economies, however, inflation targeting was actively used as a device to bring inflation down gradually, from more than 20% per year to long-term levels in the 2-4% range. Convergence has taken 11 years in Chile and more than 9 years in Israel. Their convergence speed and trajectory to the target has reflected a combination of: (i) initial macroeconomic conditions, (ii) the scope of formal indexation mechanisms and inflation inertia, (iii) credibility of the central bank, (iv) the weight of additional goals (such as deviations of employment and the real exchange rate or current account from long-term equilibrium levels) in the policy makers' objective function, (v) existence of political support for the proposed disinflation path – regarding both the speed (reflecting the degree of tolerance to the sacrifice ratio) and the final inflation goal (reflecting the view on the balance of long-term inflation costs and benefits).

We have described the differences in the design and implementation of inflation targeting under disinflation and stationary inflation. Now we briefly review the advantages and rationale of inflation targeting generally to infer about the its relative merits when using it as a disinflation device in comparison to its application to hold economies at stationary inflation.

Inflation targeting is superior in various dimensions to alternative frameworks of monetary policy (see Bernanke et al., 1999). An explicit inflation target provides an explicit commitment device that strengthens the credibility of monetary policy. It is also a better instrument of communication of monetary policy objective. An inflation target helps the public to learn about the central bank's policy function. Regarding central bank independence, an inflation target facilitates – when deemed useful – the division of monetary policy independence between goal independence (often reserved to the government) and instrument independence (granted to the central bank). Finally an inflation target provides a clear benchmark against which the central bank can be held accountable.

When converging from moderate to low inflation, the design features of inflation targets may emphasize its communicational properties. This has been reflected in the use of the headline CPI. Inflation targets have to be announced for specific time horizons (typically calendar years) because the central bank has to commit to a specific disinflation path and speed. The predominance of point over range targets during disinflation reinforce central bank instrument independence by avoiding the pressure of the political establishment of biasing monetary policy toward the ceiling of any target range. For the same reason, lack of goal independence may reduce the speed of convergence to low inflation. Finally, exemption clauses tend to be absent because they may open the door to larger deviations from target levels – one manifestation of weaker accountability of central banks and their monetary policy during convergence.

In sum, the focus of inflation targeting during disinflation is on the attainment of short-term (annual) inflation targets on a preferably monotonic path to low inflation. Success in attaining subsequent declining inflation targets reinforces credibility which in turn makes for successful inflation targeting. Hence the inflation targeting framework is potentially a very effective means by which to initiate a virtuous cycle between monetary policy and its ultimate goal. As Chile's and Israel's experience suggest, this device can be extremely successful in breaking with a long past of moderate or high inflation – even in countries where backward-looking inflation is widespread.

3. Conduct of monetary policy in Chile and monetary transmission mechanisms [v]

As discussed above, Chile adopted a monetary framework anchored on an inflation target in 1990. As part of its monetary programming, CBC monitors and projects the main monetary aggregates but does not use them as intermediate targets. Regarding the exchange rate, the CBC adopted in September 1999 a floating exchange rate system, suspending the preceding exchange rate band. Hence the exchange rate no longer plays any role as intermediate target but is also monitored and projected regularly.

Since the mid-1980s the main instrument or operational objective of monetary policy has been a past- inflation indexed interest rate (a simile of a real interest rate). The widespread use of these explicit *real* interest rates in Chilean financial markets has been a market response to historically high inflation and reflects the scope of indexation in the Chile. From 1985 through 1995 CBC used the real rate on indexed CBC paper of 90-day maturity (PRBC-90s or "Pagarés Reajustables del BCCh a 90 días"). The real rate is applied to the principal that is indexed on a daily basis to a unit of account (the UF or "Unidad de Fomento"). The latter is indexed daily to the CPI with an average lag of 20 days. Since May 1995 the policy rate is the real (UF-indexed) daily rate paid on overnight interbank loans (the real overnight interbank rate).

CBC announces publicly its policy rate and guides the market interbank rate towards the policy objective by conducting open-market operations. Since May 1995 and to date –excepting 4 months in 1998 – the difference between the policy rate and the actual interbank rate has only been, in average, 5 basis points. Open-market operations are performed by issuing CBC paper and by conducting repos and anti-repos. A monthly program of CBC paper issues is announced in advance in order to provide markets with information about the stance of monetary policy that is projected to be consistent with the real policy rate. Complementary repo and anti-repo operations are conducted during the month in order to satisfy the demand for liquidity that is consistent with the monetary policy rate.

Furthermore there are two standard facilities provided by CBC to financial institutions at their discretion: the line of liquidity credit and the liquidity deposit. The former facility provides CBC credit to individual institutions (subject to quantitative credit ceilings) at marginal interest rates that rise with the amount of the required credit to three different steps. The liquidity deposit is an open window provided to financial institutions to deposit their excess liquidity at a floor interest rate. Chart 1 depicts the evolution of market and policy interest rates in Chile since 1995.

Chile's exchange rate policy was based on a crawling exchange rate band from 1984 through September 1999. The main objectives of the band were to maintain international competitiveness and reduce excessive exchange rate volatility. However since the start of the band many of its features – including its width, rate of crawl, reference currency basket, degree of symmetry, and central parity level – were modified in response to changing policy objectives and market conditions. Intra-marginal foreign-exchange interventions by the Bank were frequent and, at times, intense. Conflicts between the inflation target and the exchange rate band were usually solved in favor of the former. Chart 2 depicts the evolution of the exchange rate band and the market real exchange, both in real terms.

Although most of the time the market interbank real interest rate stays close to the monetary policy rate, under exceptional conditions Bank policy has allowed for a temporary wedge between market and policy rates. These conditions have materialized in circumstances when pressures on the domestic currency were deemed to be excessive and temporary. Under such conditions, CBC policy has combined non-sterilized foreign-exchange interventions with a contractionary monetary policy. Such events materialized in 1998, reflecting the turmoil in international financial markets and the widespread flight of capital from all emerging economies. Chile's peso defense gave rise to high market interbank rates observed in December 1997-January 1998 and during June-September 1998. Both were temporary events after which market rates converged back to policy rates, providing support for a gradual exchange rate depreciation to take place.

The Bank's monetary policy function includes a number of key variables that are closely watched and projected. They include the gap between core inflation and the inflation target level (projected over the relevant policy horizon), the aggregate spending-income gap (or the current account deficit), the actual-potential output gap, unemployment, monetary growth, wage growth, the exchange rate, the fiscal policy stance, and the market term structure, among other variables.

How does monetary transmission operate in Chile? As in other open economies, the main channels of transmission of a change in the policy rate operate through market interest rates and the term structure, monetary and credit aggregates, and the exchange rate (Chart 3). Other relevant transmission mechanisms (not included in the latter figure) include asset prices and market expectations about the future stance of monetary policy and inflation. All the latter variables act upon (and are also affected by) other macroeconomic aggregates and key prices of goods, labor, and assets. Indexation is a structural feature of the Chilean economy that contributes to price inertia and slows down relative price adjustment, leading to a quick transmission of exchange rate and wage shocks to aggregate inflation. Information about the gap between core inflation and the inflation target, as well as from the other variables that were mentioned above, is used by the CBC in reviewing its monetary policy stance.

4. Stabilization and macroeconomic performance

After a decade of moderate but stubborn inflation, the recently independent CBC faced in 1990 various choices in its attempts bring down inflation. Chile's inflation history records two major stabilization programs based on a nominal exchange rate anchor: 1959-62 and 1979-82. Both programs failed badly – reducing the possibility of using a credible using the exchange rate anchor for a third time to bring inflation down on a sustained basis. On the other hand the use of monetary aggregates as an intermediate target would have been difficult in a country with developing financial markets and

volatile demands for monetary aggregates. The remaining choice for a monetary framework was inflation targeting.

This new approach has been successful and lasting. Annual inflation has declined from above 25% in 1990 to ca. 3% in 1999, the lowest level of inflation recorded since the 1930s. An inflation target point of 3.5% has been announced for 2000 (the last year with an annual target) and a target range of 2 to 4% has been announced for an undefined horizon starting in 2001 (Chart 3).

At the heart of this achievement have been several elements, the most significant relating to the policies implemented by CBC. Close compliance with annual inflation targets were key in influencing inflation expectations and raising CBC's credibility regarding its commitment to achieve price stability. Several other factors played important supporting roles. Fiscal policy recorded surpluses year after year from the mid-1980s through 1998. On the external side, growing capital inflows from 1989 through 1997 contributed to a real exchange rate appreciation that helped in reducing inflation.

The ultimate test of the success of disinflation based on inflation targeting came in 1997 with the Asian crisis. Its real and financial aftershocks in 1998 required a significant real exchange rate depreciation that was gradually accommodated by the CBC. As described above, CBC defended initially the peso against strong speculative pressures through a combination of foreign exchange interventions and a restrictive monetary policy. This temporary policy mix avoided an overshooting of the nominal exchange rate, allowing for a nominal and real depreciation that has been gradual and monotonic.

The large loss in the country's terms of trade and lower capital inflows in 1998-99, combined with a restrictive monetary policy in 1999, contributed to a downward correction of aggregate demand and a temporary recession in 1998-99. The reduction in excess spending over income was reflected in a necessary correction of Chile's current account position. In fact, current account deficits had shown a rising trend since the early 1990s, from ca. 1.5% of GDP in 1990-92 to a peak of 9% of GDP attained during the

fourth quarter of 1997. The required correction is reflected by a current account deficit projected at 1.5% of GDP in 1999 (Chart 5). The counterpart to this quantitative correction has been the change in the relevant relative price. After displaying a trend appreciation during 1989 97, the real exchange rate has depreciated by 24 % between September 1997 and September 1999 (Chart 2).

After a period of high and sustained real GDP growth at an average 8.1% during 1989-97, growth declined to 3.4% in 1998 and to a slightly negative figure projected for 1999 (Figure 6). With negative growth recorded between late 1998 and mid 1999, the unemployment rate rose to a peak of 11% in mid 1999 (Chart 7). A recovery from the recent recession is projected to take place in 2000, reflected in positive growth and declining unemployment rates.

The massive adverse shock that hit the Chilean economy during 1997-99, a necessitated major correction in domestic absorption and external positions. With little contribution from fiscal policy, this correction was sustained by a restrictive monetary policy stance during 1998. The subsequent success in correcting the external imbalance and meeting the inflation target meant that monetary policy could be relaxed in late 1998 and it has continued to be expansionary during 1999. We conclude that the Chilean economy is successfully emerging from the Asian storm and its after-effects. Inflation targeting is passing the test as an effective monetary framework for allowing inflation convergence to low and sustainable inflation in Chile.

5. Inflation targets and stabilization in an indexed open economy: a model

In this section we develop a simple structural model for inflation in an open economy characterized by both forward-looking monetary equilibrium and backward-looking price rigidities caused by widespread indexation practices in various markets. This model is meant to characterize the process of gradual disinflation under an inflation target rule in Chile since the early 1990s.

Aggregate inflation (Π) is a weighted average of traded-goods inflation (Π_T) and non-traded-goods inflation (Π_N):

(1) $$\Pi_t = a\,\Pi_{Tt} + (1-a)\,\Pi_{Nt}$$

where subindex t denotes time period.

Consistent with the weak version of the purchasing-power parity condition, traded-goods inflation is determined by the rate of nominal exchange rate devaluation (X) and the rate of foreign inflation (Πf):

(2) $$\Pi_{Tt} = X_t + \Pi f_t$$

Nominal devaluation is defined as the sum of the domestic-foreign inflation difference and the rate of real exchange rate depreciation (approximated by the difference of the log of the real exchange rate, e):

(3) $$X_t = \Pi_t - \Pi f_t + (e_t - e_{t-1})$$

Real (and hence nominal) exchange rate depreciation follows a process that is determined in part by a risk-adjusted interest-rate arbitrage condition and in part by the short-term influence of the crawling-peg rule that the Central Bank applied to determine the central parity of its nominal exchange rate band (abolished in September 1999). The corresponding first-order difference equation for the log of the real exchange rate is:

(4) $$e_{t+1} - e_t = k\,[r_t - rf_t - r\,(f_t)] + (1-k)\,[(\Pi_t - \Pi f_t + ad_{t+1}) + (\Pi f_{t+1} - \Pi_{t+1})]$$

where r (rf) is the domestic (foreign) real interest rate and r is a risk premium on domestic financial assets factor that depends negatively on the stock of the economy's foreign assets (f).

The second right-hand side term in equation (4) is consistent with equation (3), that has been inverted for the real exchange depreciation and shifted forward by one period. In this term, the central parity of the nominal exchange rate band follows a crawling peg rule such that the rate of nominal depreciation rule (X_t) is given by the sum of the 1-period lagged domestic-foreign inflation difference and an adjustment factor (ad) that reflects an intended real depreciation. In the long-term the latter factor tends to be equal to the negative of the traded-nontraded productivity growth differential relative to the rest of the world (the Harrod-Balassa-Samuelson effect). The latter effect is also equal to the real exchange rate depreciation in the long-term, when current and lagged inflation levels are equal to each other. In the short term, however, the real exchange rate depreciation is influenced by the nominal depreciation rule, implying that lagged domestic inflation will have a temporary effect on the real exchange rate path.

Non-traded goods inflation reflects the influence of three variables: past aggregate inflation (because of widespread indexation practices in non-traded goods markets), contemporaneous nominal wage growth (Ω) adjusted for non-traded labor productivity growth, and a forward-looking long-term inflation expectations term as of period t-1 (Π^e). The latter expectations term is different from actual inflation expectations (more on this below). Therefore:

$$(5) \qquad \Pi_{Nt} = b_1\Pi_{t-1} + b_2\left(\Omega_t - l_{Nt}\right) + \left(1 - b_1 - b_2\right)\Pi^e_{t-1,t}$$

Nominal wage growth reflects the influence of three variables: real growth of aggregate labor productivity (l , a weighted average of productivity growth in the traded and non-traded sectors), indexation to current and past inflation, and labor market pressures embodied by the deviation of unemployment (u) from its natural or full-

employment level (u^*). Hence wage growth follows a standard Philips curve modified to take account of indexation practices:

(6) $$\Omega_t = l_t + w\,\Pi_t + (1-w)\Pi_{t-1} + s\left(u^* - u_t\right)$$

Temporary unemployment reflects the influence of the temporary deviation of the domestic real interest, r, from its parity level (rp). To simplify, the market interest rate is assumed to be equal to the Central Bank policy rate. Therefore unemployment (and hence wage growth) only reflects the stance of monetary policy:

(6) $$u^* - u_t = n\left(rp_t - r_t\right)$$

The interest parity level is defined as the foreign real interest rate augmented by the rate of expected real exchange rate depreciation and the country risk premium factor.

Substituting equations (2)-(3) and (5)-(7) into equation (1) yields the following semi-reduced form for inflation in period t, written in general form as function Π:

(8) $$\Pi_t = \Pi\left(\Pi_{t-1},\ \Pi f_t,\ e_t - e_{t-1},\ ad_t,\ l_t - l_{Nt},\ rp_t,\ \Pi^e_{t-1.t}\right)$$

It can be shown that in steady state, when current and lagged inflation coincide, the combined influence of foreign inflation, real exchange rate depreciation, and the real exchange rate appreciation factor on inflation is zero. Hence in steady state, actual (and expected) inflation (Π^*) has to be equal to forward-looking long-term inflation expectations:

(9) $$\Pi^* = \Pi^e_{t-1.t}$$

Now let's focus on the process of formation of long-term inflation expectations that play an important role in non-traded price inflation. In fact, these expectations provide the forward-looking anchor to the process of short-term actual and expected inflation levels. Long-term inflation expectations will be derived as a rational forecast of domestic inflation consistent with monetary equilibrium under rational-expectations in the above of backward-looking inflation indexation. A standard form of money demand with constant semi-elasticity of interest and unit income elasticity is assumed:

$$(10) \qquad m_t - p_t = -e\left[E_t Pt+1 - p_t + \mathrm{r}_t\right] + y_t$$

where m is nominal money, p is the price level that would prevail in the absence of indexation, y is income, and E is the expectations operator conditional on all contemporaneous information.

By inverting the latter equation obtain the following stochastic first-difference equation for the price level:

$$(11) \qquad p_t = \frac{1}{1+e}\left[m_t + e\,\mathrm{r_t} - y_t\right] + e\,E_t\,p_{t+1}$$

By forward substitution obtain:

$$(12) \qquad p_t = \frac{1}{1+e}\sum_{s=t}^{\infty}\left(\frac{e}{1+e}\right)^{s-t} E_t\left[m_s + e\mathrm{r}_s - y_s\right] + \lim_{\mathrm{T}\to\infty}\left(\frac{e}{1+e}\right)^{T} p_{t+T}$$

where the latter limit term is zero by imposing the condition that rules out speculative bubbles.

Shifting equation (12) by one period forward, taking expectations and subtracting (12) from the latter yields long-term rational inflation expectations as a function of the

present value of current and future interest monetary growth, real income growth, and real interest rate changes:

$$(13)\quad \Pi^{e}_{t,t+1} \equiv E_t\, p_{t+1} - p_t = \frac{1}{1+e} \sum_{s=t}^{\infty} \left(\frac{e}{1+e}\right)^{s-t} \left\{E_t\left[m_{s+1} - m_s\right] + e\; E_t\left[r_{s+1} - r_s\right] - E_t\left[y_{s+1} - y_s\right]\right\}$$

In order to obtain a useful expression for long-term expectations in terms of currently observable variables, we impose the following assumptions about the behavior of the right-hand variables in equation. (13). Note that we specify independent processes for both monetary growth and real interest rates – however one of them is redundant. In fact, under Chile's real interest-rate policy, money supply is the adjusting variable.

Money growth is assumed to follow a weighted average of an AR(1) process of itself and the pre-committed inflation target (added to real income growth):

$$(14)\quad m_{s+1} - m_s = dg\left(m_s - m_{s-1}\right) + \left(1-d\right)\left[\Pi t_{\,s+1} + \left(y_{s+1} - y_s\right)\right] + h_{1,\,s+1}$$

The AR(1) part of the process has a first-order coefficient of c and its weight in current money growth is d. If only the inflation target governs monetary policy, d is equal to zero.

The policy interest rate is defined consistently with the monetary growth process above. The deviation between the interest rate and its parity level is a positive function of the difference between steady-state ((m-p)*) and actual money holdings:

$$(15)\quad r_s = rp_s + q\left(\left(m_s - p_s\right)^{*} - \left(m_s - p_s\right)\right) + h_{4,\,s+1}$$

The central bank determines the inflation target according to the following AR1 process:

(16) $\Pi t_{s+1} = \gamma \Pi t_s + h_{2,\,s+1}$

and income growth also follows an AR1 process:

(17) $y_{s+1} - y_s = \mu (y_s - y_{s-1}) + h_{3,\,s+1}$

Substituting equations (14)-(17) into equation (13) yields the following semi-reduced form for long-term expectations in period t, written in general form as:

(18) $\Pi^e_{t,t+1} = g (\Pi t_{t+1},\ rp_t - r_t,\ m_t - m_{t-1},\ y_t - y_{t-1})$

As money is endogenous to the setting of the interest rate, it can be substituted as a function of the interest rate (from equations 14 and 15) to obtain a more compact version of the preceding equation:

(18') $\Pi^e_{t,t+1} = h (\Pi t_{t+1},\ rp_t - r_t,\ y_t - y_{t-1})$

The final reduced-form equation for inflation is obtained by substituting forward-looking long-term inflation expectations from equation (18) (or 18') into equation (8):

(19) $\Pi_t = f\ (\Pi_{t-1}, \Pi f_t, e_t - e_{t-1}, ad_t,\ l_t - l_{Nt}, rp_t - r_t,\ \Pi t_t, rp_{t-1} - r_{t-1},$
$m_{t-1} - m_{t-2}, y_{t-1} - y_{t-2})$

Note that short-term or actual inflation expectations are consistent with the latter expression for inflation. Short-term monetary equilibrium is obtained by substituting the expected value of equation (19) into a monetary equilibrium condition analogous to equation (10).

Finally consider a standard first-order difference equation for foreign asset accumulation that reflects the open economy's balance-of-payments equilibrium:

$$(20) \qquad f_{t+1} - f_t = nx\left(e_t, f_t, r_r\right) + r_t^* f_t$$
$$(+)\ (-)\ (-)$$

where f is net foreign assets at the beginning of each period, nx is net exports (a function of the real exchange rate, the domestic real interest rate, and the stock of net foreign assets), and r* is the foreign real interest rate. Also note that nx is equivalent to the excess supply of traded goods.

Figure 8 depicts monetary and external equilibria in our open economy. Panel 1a shows that monetary equilibrium holds along equilibrium schedule MM. This schedule reflects monetary equilibrium equation (10) corresponding to inflation expectations consistent with equation (19). Steady-state equilibrium is attained when actual inflation coincides with both the inflation target and long-term expected inflation, that is, when the first difference equation implicit in (19) is zero. Note that dynamic adjustment of inflation and monetary holdings affects the external adjustment path and vice-versa.

Panel 1b shows the economy's combination of the real exchange rate and the stock of net foreign asset holdings that satisfies external equilibrium. The corresponding pair of steady-state equilibrium conditions derived from equations (4) and (20) exhibits a saddle-path equilibrium along schedule SS.

Figure 9 depicts the dynamic adjustment to a permanently lower inflation target – supported by a more restrictive monetary policy – in an open economy characterized by sluggish inflation adjustment due to widespread indexation. Under sluggish inflation adjustment, the central bank's rise in the domestic interest rate could raise by more than the contemporaneous decline in (actual and expected) inflation, implying an increase in the nominal interest rate and hence a decline in real monetary holdings. Therefore the impact effect is from point A to point B' in panel 2a. Subsequently inflation starts to

decline, allowing a gradual easing of monetary policy. Steady-state convergence is achieved at point C, when inflation has attained the target level and is consistent with long-run inflation expectations, and real money holdings have grown accordingly. The real interest rate is back at its initial steady-state level determine by its parity level.

External adjustment (panel 2b) involves on impact a real exchange rate appreciation, caused by both the temporary rise in the domestic real interest rate and the influence of lagged inflation (which exceeds contemporaneous inflation) on the backward-indexed central parity of the exchange rate band. Subsequently the exchange rate appreciates, gradually returning back to its initial level at point A. The temporary exchange-rate appreciation causes a temporary current-account deficit, financed by foreign-asset decumulation. Subsequent exchange-rate correction leads to an ultimate reversal in the net foreign asset position, back to initial equilibrium at point A.

Finally panel 2c shows the dynamic adjustment of the model's main variables to the announcement of a lower inflation target.

Note that the non-neutrality of the stabilization policy – i.e., the result that adjustment takes time and has temporary real effects on asset holdings, relative prices, and employment levels – reflects two key features of the model: (i) inflation sluggishness due to backward indexation in non-traded goods and labor markets as well as the exchange-rate indexation rule, and (ii) the fact that monetary policy follows partly its own history so that the inflation target plays only a partial role in setting the current policy stance. Therefore the lower is inflation inertia and the larger is the role of the target in setting monetary policy, the quicker and the less costly is the adjustment to a new inflation target.

6. Inflation Targets and Inflation Reduction in Chile during the 1990s

This section assesses the role of inflation targeting in reducing inflation in Chile during the 1990s. The issue is if the inflation target has been a credibility-enhancing device that has contributed to gradual convergence to low stationary inflation. We approximate this question by comparing model-based forecasts for future inflation, based on information available just before the announcement of each annual inflation target, with the subsequently known inflation target and actual inflation outcome during the corresponding forecast horizon. If the inflation forecast is systematically above target and actual inflation levels, we infer that (credible) inflation targeting during the decade has helped in Chile's convergence to low inflation at the end of the 1990s.

We inspect the above mentioned question by using a VAR model with as few restrictions as possible. While this approach is largely non-theoretical, our choice of endogenous and exogenous variables reflects statistical relations that are loosely based on theoretical, common-sense priors. We have explored four alternative VAR specifications: with and without a time trend reflecting the monotonic and downward convergence of inflation to low levels; and with and without the nominal exchange rate as a variable.[vi] While this approach lacks a causal and structural interpretation of the variables included in the VAR, it provides potentially more robust evidence than that based on a more restrictive structural model.

The monthly data series for the period 1983-1998 are depicted in Figures 10a and 10b.[vii] The macro variables we plot comprise: headline CPI inflation (IPC), core or underlying CPI inflation (SUBIPC), foreign inflation (IPEXT), nominal exchange rate growth (TCN), nominal wage growth (WAGES), nominal money growth (MONEY), real output growth (IMACEC), the indexed interest rate used as the instrument of monetary policy (TASA), and the inflation target (META).

Inspecting the data reveals the cycles and trends of the Chilean economy during the last 16 years. The business cycle is well reflected by the movements of output growth

and real wage. With respect to the nominal variables, a strong downward trend in all nominal growth rates emerges in 1991. For example headline and core inflation fall from annual rates of ca. 25% in the 1980s to ca. 5% in 1998. This is a first and casual indication of a regime change that coincides with the adoption of inflation targeting, embodied in a monotonic reduction in pre-announced annual inflation targets. However, the relevant international inflation rate and nominal exchange rate for Chile have also declined during most of the 1990s. Hence simple data inspection does not shed light on the contribution of the inflation target in bringing actual and expected inflation down. In order to identify the latter effect, we need to clean the evolution of inflation from other determinants of the inflation rate.

We do this by comparing inflation forecasts based on an unrestricted VAR model with the actual inflation outcome of inflation and the inflation target. Recall that inflation targets are announced by the Central Bank each September and are defined for the subsequent calendar year. The VAR is estimated for each policy announcement using the information available up to the month that predates the target announcement. The forecast is dynamically simulated for sixteen months ahead (from September of the current year through December of the next year), obtaining an inflation forecast for the period of the corresponding target. This means that we estimate seven VARs, each additional one with 12 additional monthly observations, and one VAR for every inflation target announcement of the 1990-1996 period.

The unrestricted VAR includes six endogenous variables (interest rate, wages, GDP, CPI, money, nominal exchange rate) and two exogenous variables (terms of trade and relevant foreign CPI). Since we run this VAR to make a forecast we treat the exogenous variables as endogenous so that they are included in the dynamic forecast. The VAR is estimated with and without inclusion of a trend (as an exogenous variable).[viii]

The data we use in the VAR are the following: [ix]

1. Seasonally-adjusted (sa) monthly real output growth (IMACEC)
2. sa monthly foreign inflation rate (IPCEXT)
3. sa monthly nominal exchange rate growth (TCN)
4. sa monthly inflation rate (IPC)
5. sa monthly money growth (MONEY)
6. sa nominal wage growth (WAGES)
7. 90-365 day financial-system interest rate (TASA)
8. Rate of change of the terms of trade (TTRADE).

In order to determine the optimal lags of the model we first run the VARs for the whole sample period. AIC (Akaike) and (SIC) Schwarz (SIC) Information Criterion results and likelihood ratio test (LRT) results for the VARs are reported in Table 2. The information criteria and likelihood ratio test results do not provide conclusive answers with respect to the optimal lag structure. AIC signals two lags while SIC signals one; for VAR1 LRT signals four lags while for VAR2 LRT signals five lags. Since there are no major differences in the results between four and five lags, we choose four lags for the VAR dynamic forecast models.

The results are presented in Figures 11 (with time trend) and 12 (without time trend). The gray range or line depicts the inflation target range or target point announced after the last period on which the out-of-sample inflation forecast (the thin black line) is based on. Actual inflation is given by the thick black line.

The first and expected result is that the forecasts based on the VARs that include a time trend (in Figure 11) are much closer to actual inflation than the forecasts based on VARS without the trend (in Figure 12). This reflects the negative trend in annual inflation observed during the 1990s.

The second and main result is that inflation forecasts are typically higher than both target and actual inflation rates. This suggests that the systematic attainment of

declining annual inflation targets contributed to a correction of inflation expectations and forecasts. In the absence of credible September announcements of future lower inflation targets, the best (model-based) forecast of future inflation reflects a mean reversion to higher (i.e. historical) rates of inflation in the future. The results suggest that the September target announcements helped in correcting inflation forecasts downwards.

The results are less clear-cut in Figure 11, where inflation forecasts are based on a VAR model that includes a time trend. The latter trend is likely to proxy the markets' expectations about a declining inflation trend, itself a function of the credible attainment of a declining inflation path by the Central Bank. However the results are very strong in Figure 12, where the VAR model excludes a time trend. Here in 6 out of 7 cases the out-of-sample forecasts show increasing divergence of inflation forecasts from both actual and target inflation rates over time. This suggests that inflation targeting has allowed to break with inflation history, leading to a gradual downward correction of actual and expected inflation.

We conclude that, for most specifications and sample periods, the inflation target was below the forecast and actual inflation was closer to the target than to the forecast. Although these results do not provide conclusive evidence, they suggest a prominent role played by inflation targeting in reducing inflation. Indeed, a major transmission mechanism of Chile's monetary framework based on inflation targeting may be the credible announcement of the target. The use of a pre-announced inflation objective by a central bank that is strongly committed to its achievement may have overcome the strong mean-reverting effects of inflation inertia in a country with so widespread indexation practice as is Chile. The results reported above provide suggestive evidence that the inflation target has served two purposes: a credibility-enhancing device for the conduct of monetary policy and effective year-to-year communication of information from the central bank to the markets.

7. Conclusions

Chile was among the first countries to adopt an inflation target. Its long inflation history had led to widespread backward-looking indexation in goods, labor, and financial markets as well as in policy instruments. While indexation exacerbates inflation inertia, this paper has provided evidence that adoption of inflation targets by an autonomous Central Bank since 1990 has made possible a regime change reflected in gradual inflation convergence toward international levels. Assessing Chile's targeting experience in an international context and analyzing the conduct of monetary policy in Chile provides the background for understanding its recent stabilization experience. A simple dynamic model was developed to illustrate the role and macroeconomic effects of inflation targeting in a highly indexed open economy. VAR estimations for inflation, inflation targets, and related macro variables have provided support to the notion that introducing forward-looking inflation targets has contributed to breaking inflation expectations, paving the way for Chile's convergence to sustainable low inflation.

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INFLATION TARGETS AND STABILIZATION IN CHILE

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Central Bank of Chile
November 1999

Tables and Figures

Tables

Charts and Figures

Table 1
International Experience with Inflation Targets

	1. Adoption Date, Initial Target, Current Target	2. Long Term Target. Years of Convergence from Adoption to Steady State	3. Index used for Targeting	4. Target Horizon	5. Exemptions or Escape Clauses
COUNTRIES CONVERGING TO STEADY-STATE INFLATION RATES					
Chile	Started Sept. 1990, initial range 15% - 20%. Current Target ± 4.3 %.	2-4% for 2001 onwards. 11 years.	Consumer price index.	Annual, Dec. to Dec. Until 2000. Unlimited for 2001 onwards.	None.
Israel	Started 1991, initial target 14-15%. Current target 4%.	3-4% (2000-01). 9 years +.	Consumer price index.	2000-01	None.
COUNTRIES AT STEADY-STATE INFLATION RATES					
New Zealand	Started March 1990, initial range 0-2%. Current range: 0-3%.	0-3%. 1.5 years.	Consumer price index, excluding various items.	Governor's term of office.	When target missed, RBNZ presents a *Policy Statement*, announcing corrective measures.
Canada	Started Feb. 1991, initial range 2-4%. Current range 1-3%.	1-3%. 1 year.	Consumer price index, excluding various items.	1998-2001.	Target range not absolutely rigid, but deviations expected small and temporary.
United Kingdom	Started Oct. 1992, initial range 1–4%. Current target 2.5% ± 1%.	2.5% ± 1%. 1.5 years.	Retail price index, excluding mortgage interest payments (RPIX).	Parliamentary period.	BoE required to write open letter to Chancellor when deviating from target range.
Sweden	Started Jan. 1993, initial and current target 2% ± 1%.	2% ± 1%. 1 year.	Consumer price index.	Unlimited.	Target range not absolutely rigid, but deviations expected small and temporary.
Australia	Started Sep. 1994, initial and current range 2-3%.	2-3%. 0 year.	CPI excluding various items.	Unlimited.	Target must be maintained on average in the medium term; small temporary deviations allowed.

Table 2

VAR Models:

Information Criteria and Likelihood Ratio Test Results (Chile, 1983-1998)

VAR 1				
	AIC	SIC	LRT to MAX	LRT to NEXT
1 lag	-36.53	-35.41*	385.26	200.24
2 lags	-36.89*	-34.91	185.02	123.87
3 lags	-36.83	-34.00	61.14	28.12*
4 lags	-36.65	-32.94	33.01*	25.50*
5 lags	-36.45	-31.85	7.51*	-
6 lags	-36.15	-30.66	-	-
VAR 2				
	AIC	SIC	LRT to MAX	LRT to NEXT
1 lag	-36.40	-35.41*	391.50	211.42
2 lags	-36.83*	-34.97	180.07	121.43
3 lags	-36.76	-34.05	58.63	27.33*
4 lags	-36.57	-32.98	31.30*	19.86*
5 lags	-36.34	-31.87	11.43*	-
6 lags	-36.06	-30.70	-	-

Note: AIC (SIC) is the Akaike (Schwarz) Information Criterion. LRT to MAX is the likelihood ratio test with respect to the model with six lags. LRT to NEXT is the likelihood ratio test with respect to the model with one additional lag.

* The null hypothesis that the model with less lags is better cannot be rejected.

Chart 1
Monetary Policy Rates and Overnight Interbank Rate
(Chile, 1997-1999; Indexed
Rates)

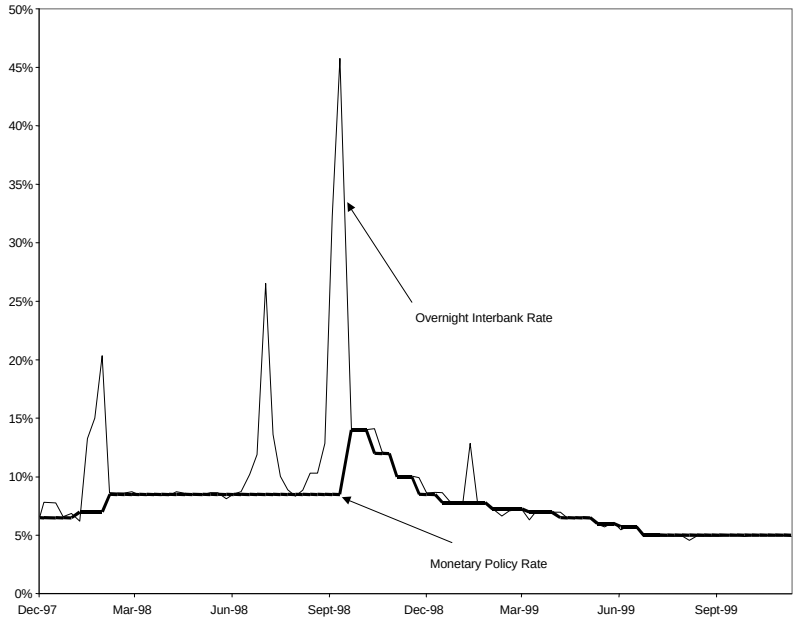


Chart 2
Real Exchange Rate Band and Market Real Exchange Rate Indexes
(Chile: 1984-1999; 1986 average=100)

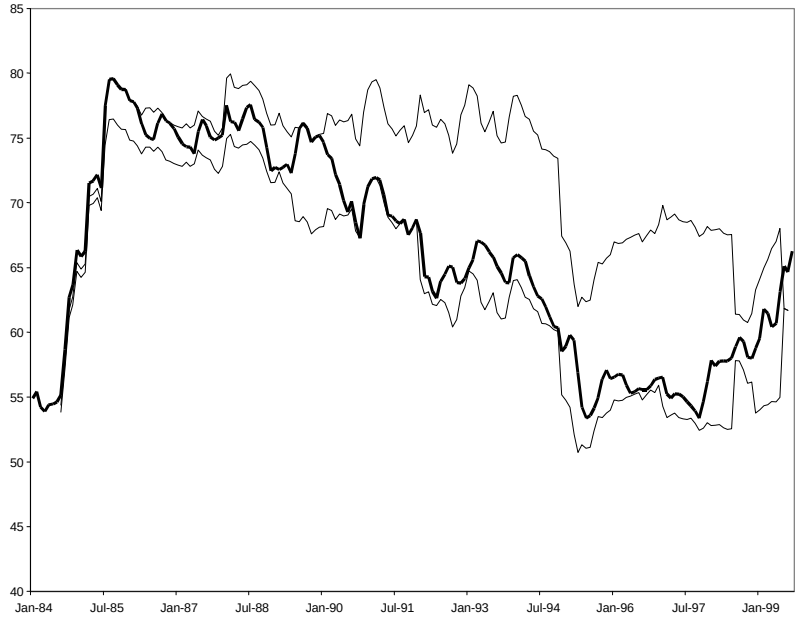


Figure 3
Channels of Monetary Transmission in Chile

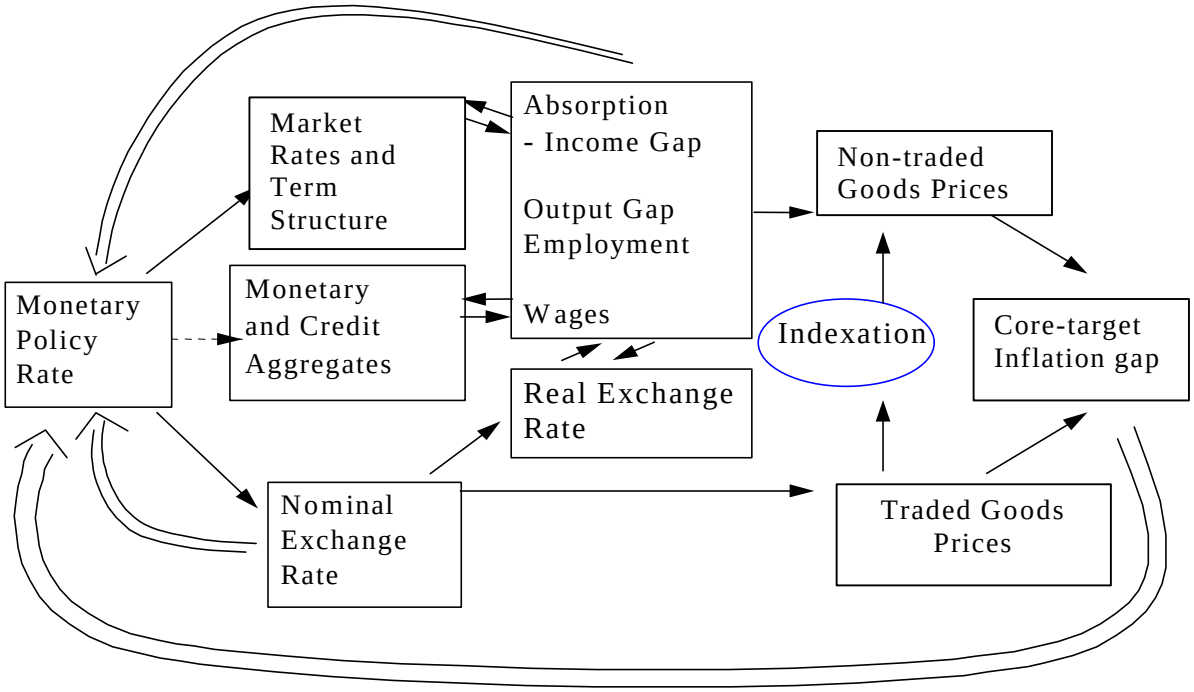


Chart 4
Inflation Targets and Actual Inflation

(Chile, 1987-2002)

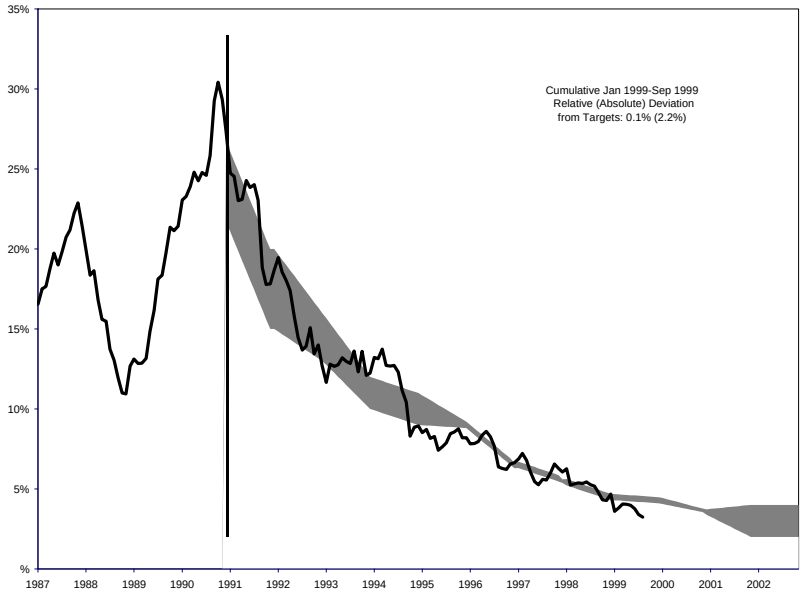


Chart 5
Current Account Ratio to GDP

(Chile, 1989-1999)

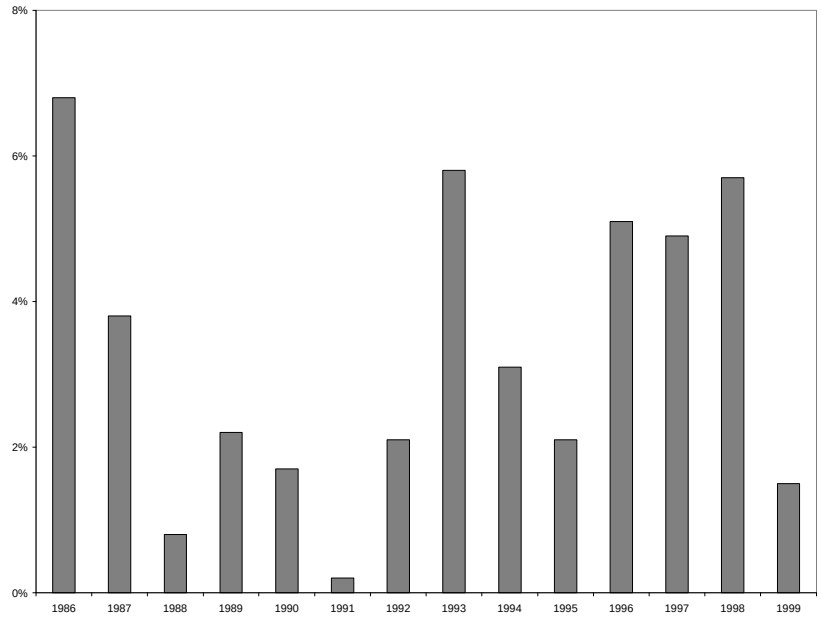


Figure 6

Actual GDP and Trend GDP

(Chile, 1977-1999; in logs)

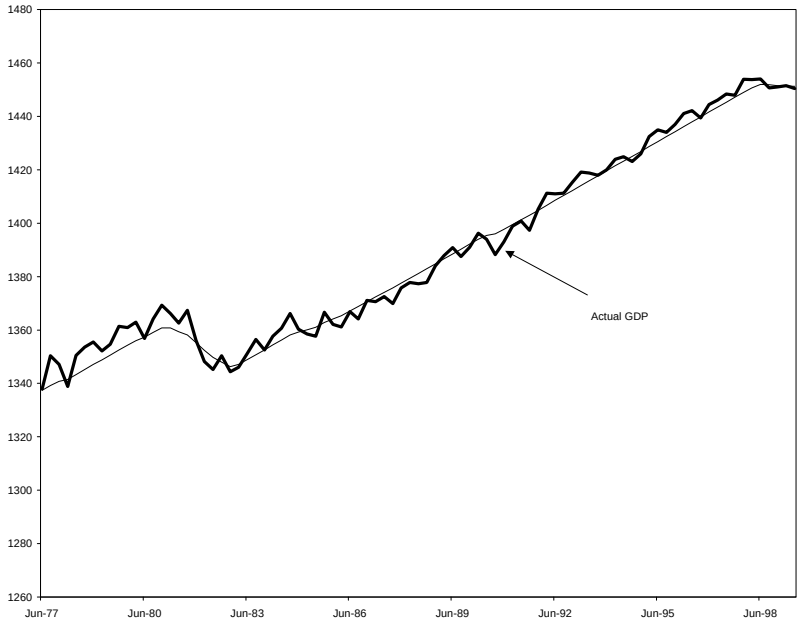


Figure 7

National Unemployment Rate

(Chile, 1990-1999)

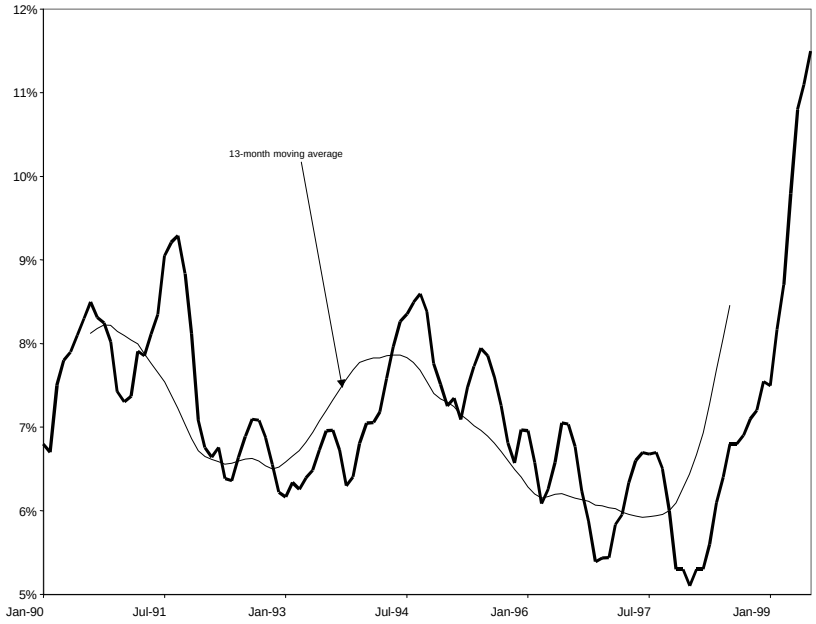
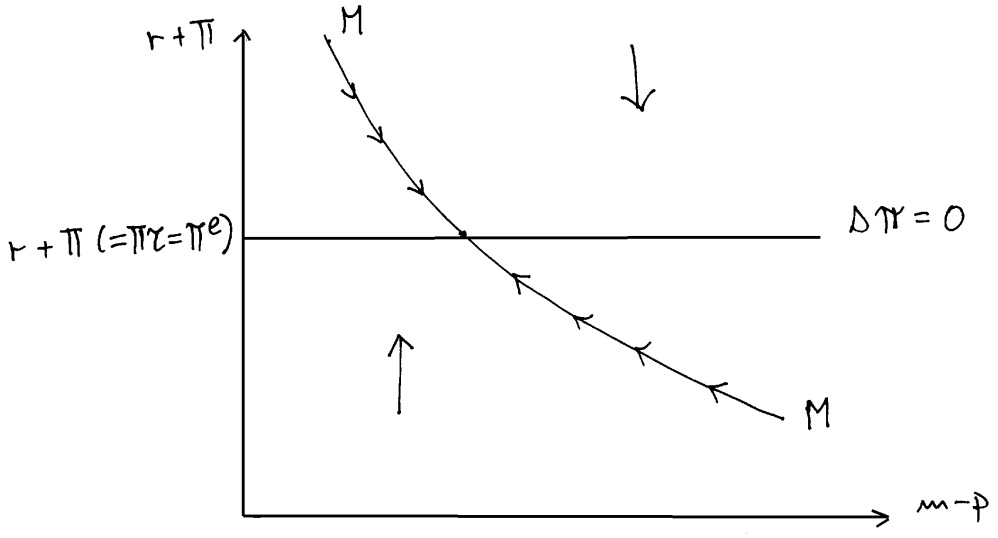
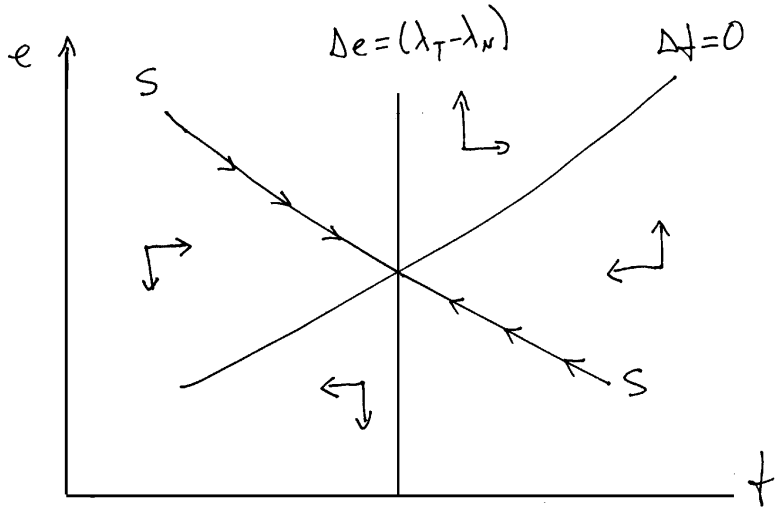


Figure 8

Monetary and External Equilibria in an Open Economy



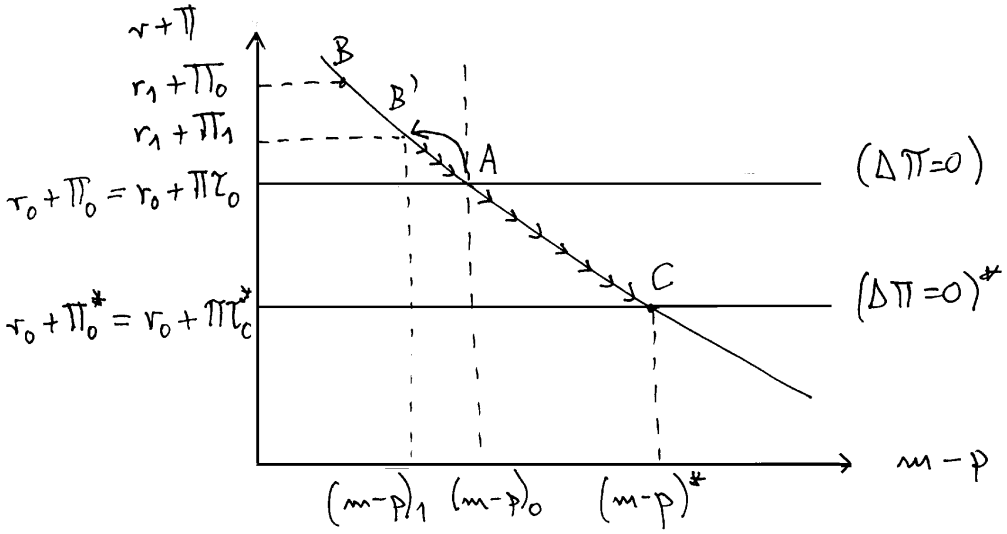
Monetary Equilibrium



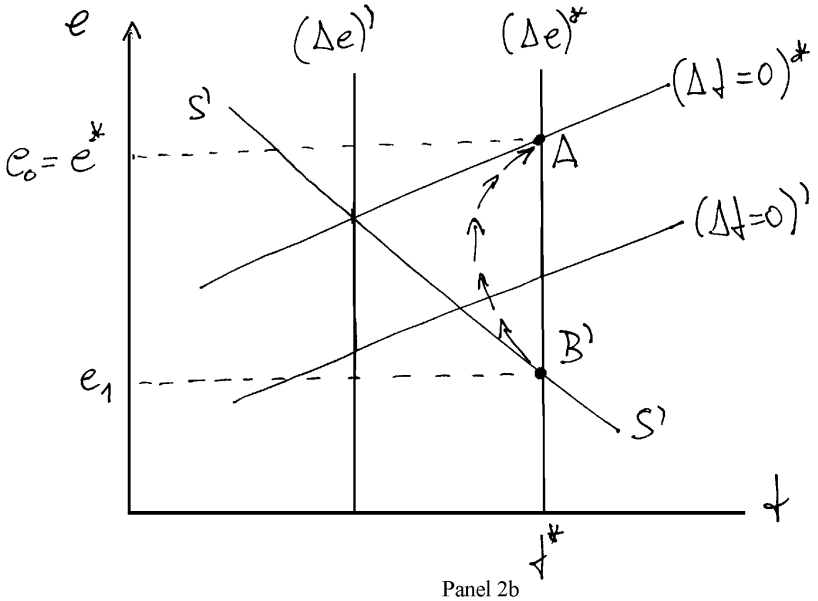
External Equilibrium

Figure 9

Adjustment to a Low Inflation Target in an Indexed Open Economy



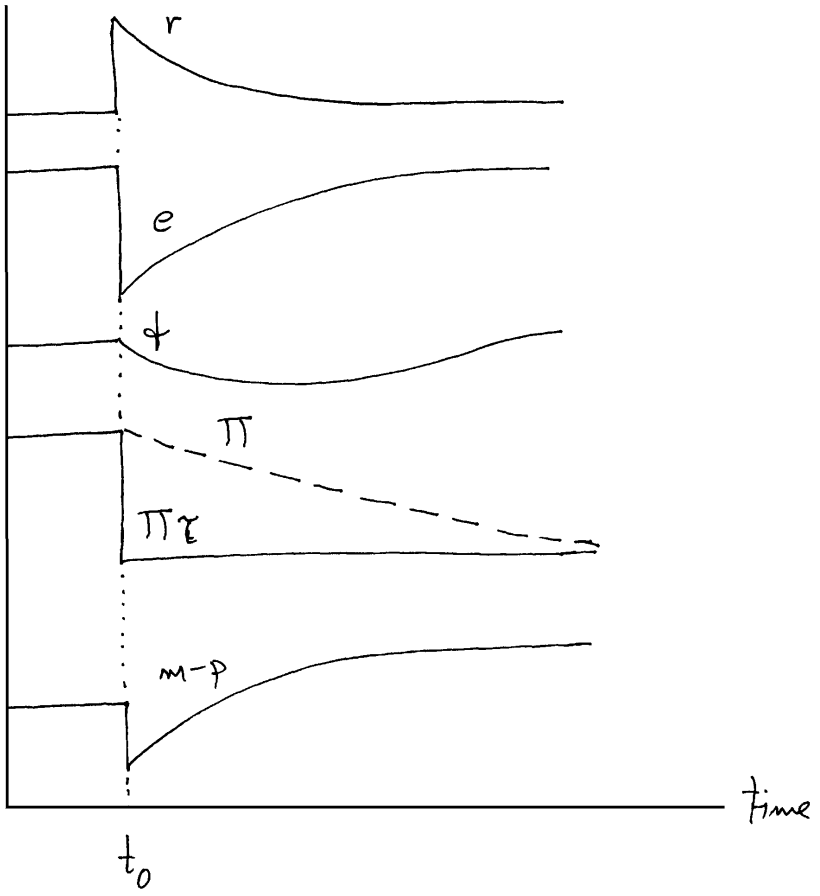
Panel 2a



Panel 2b

Figure 9 (continued)

Adjustment to a Low Inflation Target in an Indexed Open Economy (continued)



Panel 2c

Chart 10a

Inflation and Related Macroeconomic Variables

(Chile 1983-1998; 12-month growth rate, when applicable)

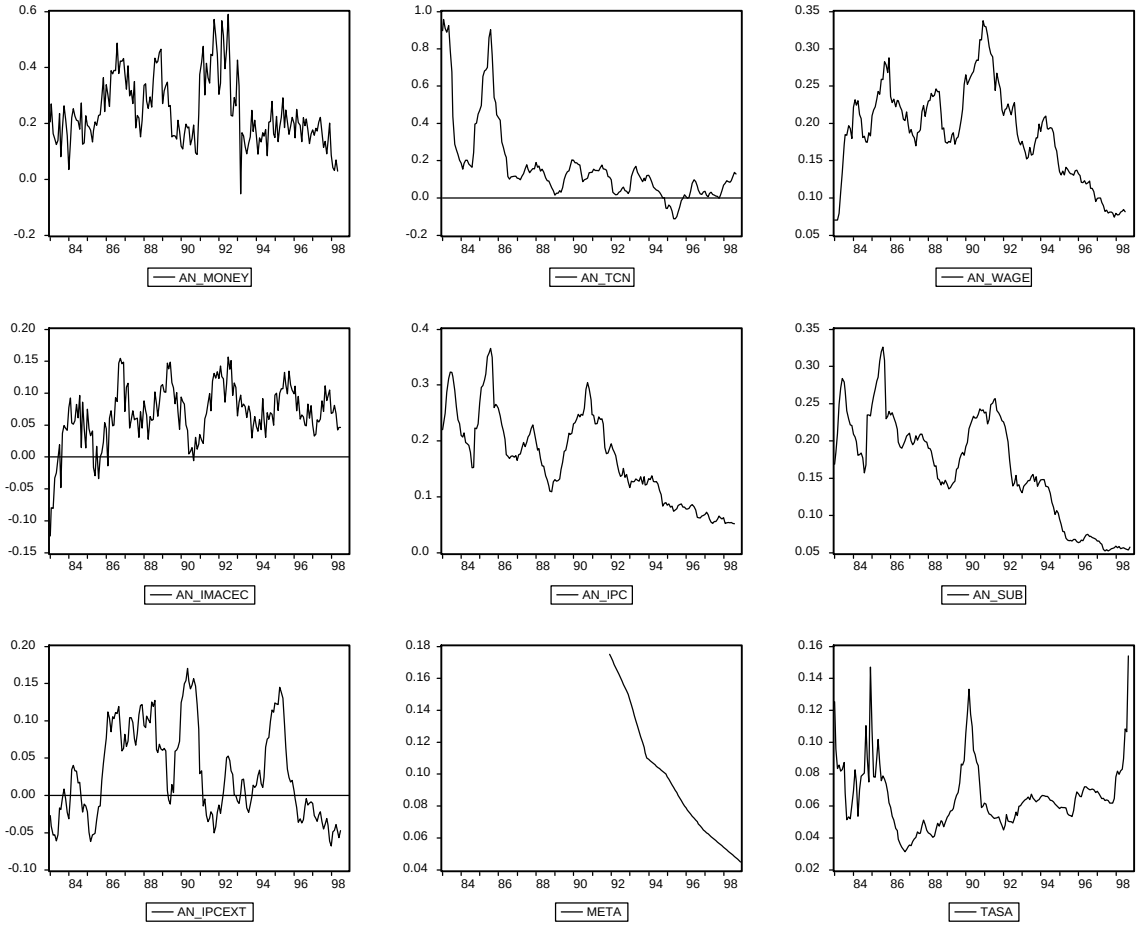


Chart 10b

Inflation and Related Macroeconomic Variables

(Chile 1983-1998; seasonally-adjusted annualized monthly growth rate, when applicable)

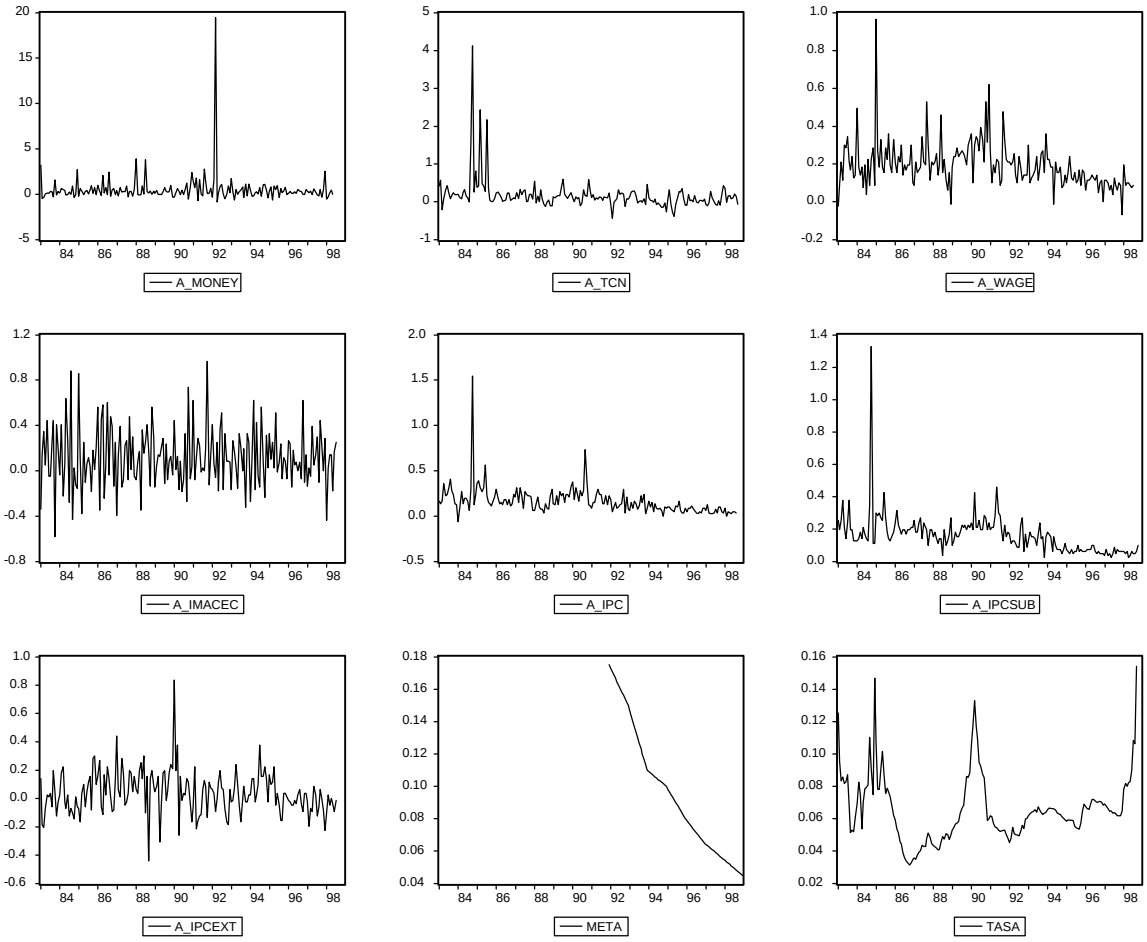


Figure 11

VAR 2.1: Inflation Targets and Forecasts, with NER, with Trend

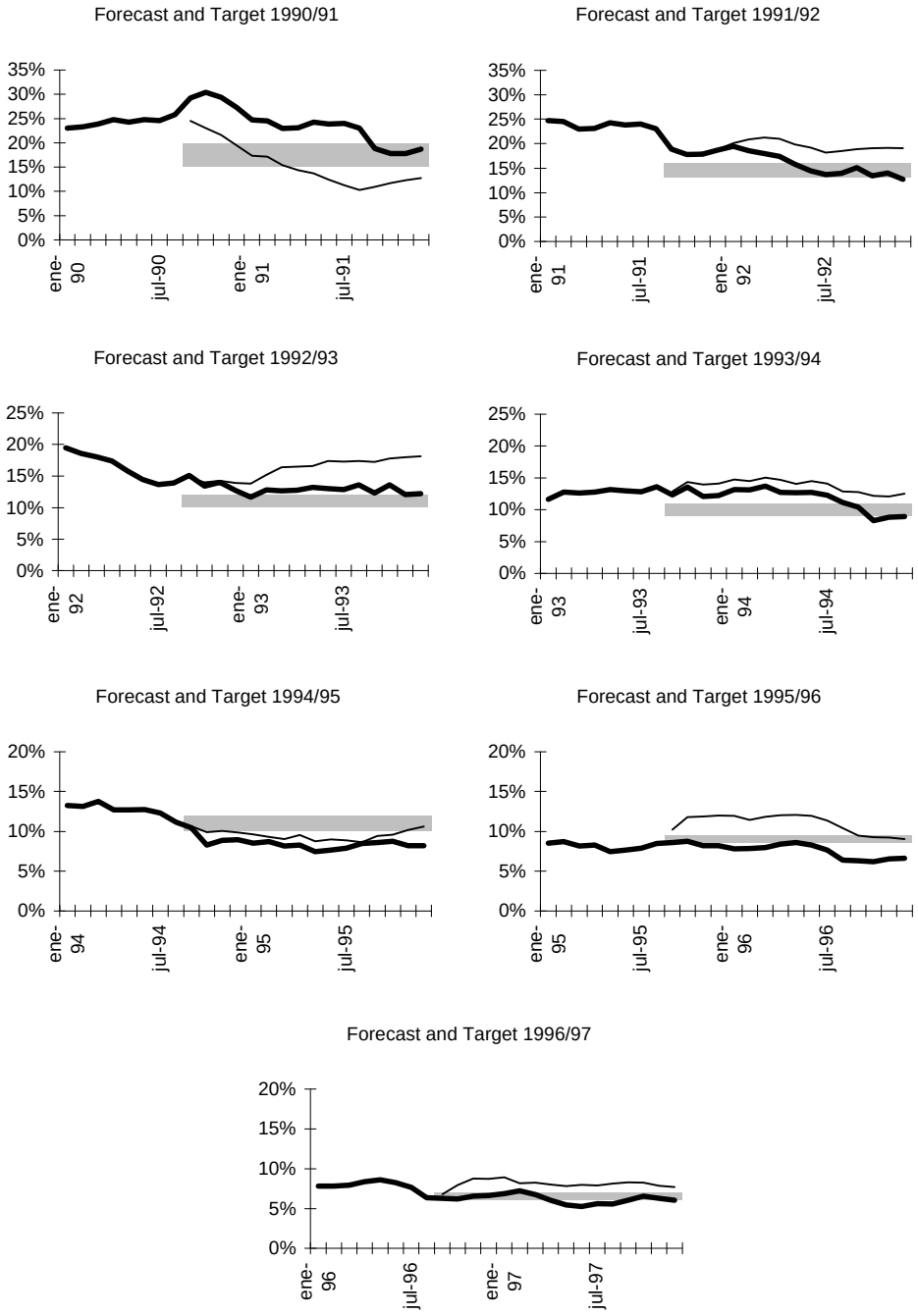
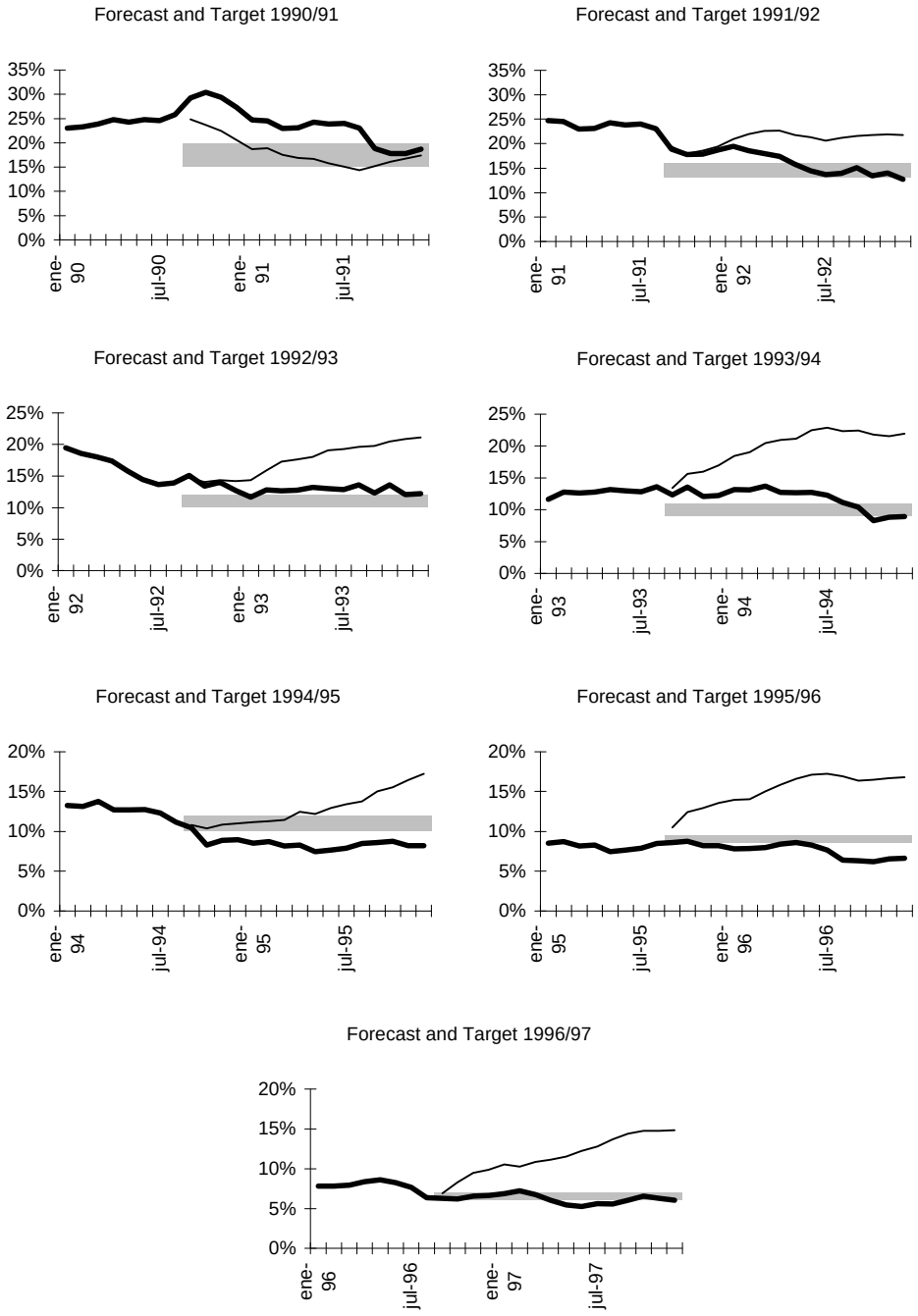


Figure 12

VAR 2.2: Inflation Targets and Forecasts, with NER, without Trend



[i] The indexed exchange rate started in 1984 was suspended in September 1999 when a floating exchange rate system was adopted by the Central Bank of Chile.

[ii] A growing literature on inflation targeting focuses analyzes the differences with alternative monetary arrangements and assesses country experiences. Among recent studies are Leiderman and Svensson (1995), Fischer (1996), Masson, Savastano, and Sharma (1997), Debelle, Masson, Savastano, and Sharma (1998), Bernanke, Laubach, Mishkin, and Posen (1999) and Fry, Julius, Mahadeva, Roger, and Sterne (1999).

[iii] Among the recent discussions of the "sand in the wheels" and "grease in the wheels" arguments for optimal imflation and empirical results are Card and Hyslop (1996), Feldstein (1996), Akerlof, Dickens and Perry (1996), and Groshen and Schweitzer (1997).

[iv] The Boskin commission calculated CPI measurement bias at around 1.5% per year for the U.S.

[v] A more detailed analysis of monetary policy in Chile is presented by Massad (1998).

[vi] Below we only report the results of the two VARs that include the nominal exchange rate below because those that exclude the exchange rate are very similar to the former results.

[vii] We report data for 12-month growth rates and seasonally-adjusted (sa) annualized monthly growth rates for most variables in Figures 10a and 10b, respectively. The exceptions are the target inflation rate (which is announced as an annual December-to-December percent rate of change of the CPI) and the real interest rate. While monthly and quarterly Chilean data are typically reported as 12-month rates of change, the drawback of this choice is that it reflects annual changes and not the corresponding month's change, implying excessive data smoothing. Our alternative sa data presents more relevant information on the corresponding month's change but has the drawback of relying on a particular seasonal adjustment method (the ARIMA X-11 procedure).

[viii] We do not report confidence intervals for the forecasts based on the VARs. Since the forecasts are dynamic, their variance grows with time: each forecast's precision declines compared to that of the preceding month. Therefore forecast confidence intervals beyond the first month are not meaningful.

[ix] Data definitions and sources are the following. IMACEC is the Monthly Index of Economic Activity of the Central Bank of Chile. IPCEXT is the Average Price Index for Chilean Trade of the Central Bank of Chile for Jan. 1982 - April 1997; it is the Relevant External Inflation Index for Chile for April 1997 onwards. TCN is the $/US$ nominal exchange rate. IPC is the Consumer Price Index of the National Institute of Statistics. MONEY is M1 published by the IMF (IFS). WAGES is the Nominal Hourly Wage Index of the National Institute of Statistics. TASA is the average real interest rate of the financial system for 90-365-day deposits published by the Central Bank of Chile. TTRADE is the terms of trade index for export and import prices of the Central Bank of Chile.

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