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A TALE OF TWO CRISES: CHILE AND MEXICO

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ABSTRACT

The Mexican peso crisis of December 1994 sent shock waves through the world's financial and policy communities. What is to some extent surprising, however, is not that the Mexican economy faced a major currency crisis, but that so many analysts and observers were shocked by this turn of events. Mexico had a remarkable historical precedent: merely a dozen years earlier Chile suffered a prophetically similar crisis. Like Mexico during the 1980s, Chile during the 1970s undertook major structural reforms characterized by a drastic opening of the economy, a sweeping privatization program and a major deregulation effort aimed at creating a modern financial sector. In Chile, as in Mexico more than a decade later, the use of a predetermined exchange rate to eliminate inflation, combined with very large capital inflows that were intermediated by a weak banking system, generated a situation of exchange-rate overvaluation, a vulnerable financial sector and eventually the collapse of the currency.

This paper provides a comparative analysis of some macroeconomic aspects of the Chilean and Mexican crises. The discussion emphasizes a question of increasing concern in academic circles: to what extent are exchange-rate-based stabilization programs successful in reducing -- or even eliminating -- inflationary inertia? The paper provides a brief overview of the Chilean and Mexican reform and stabilization programs initiated in 1975 and 1985. I develop a theoretical model on the effects of exchange-rate-based stabilization programs on inflationary inertia. The model emphasizes the roles of government preferences and credibility. I use detailed data on Chile and Mexico to assess whether these programs affected the time series properties of inflation; more specifically, I investigate whether they reduced inflationary inertia.

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A Tale of Two Crises: Chile and Mexico*

by

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The Mexican peso crisis of December 1994 sent shock waves through the world's financial and policy communities. Analysts and brokers alike were surprised by the collapse of the peso and by the ensuing chaos. Editorialists asked "Who Lost Mexico?", and congressional committees tried to determine the degree of responsibility of the U.S. administration and of the multilateral organizations. The international media wondered what the crisis meant for the much heralded take-off of the "emerging economies". If Mexico was one of the best examples of a successful reformer, some observers asked, what could be expected of other cases?

What is to some extent surprising, however, is not that the Mexican economy faced a major currency crisis, but that so many analysts and observers were shocked by this turn of events. Mexico had a remarkable historical precedent: merely a dozen years earlier Chile suffered a prophetically similar crisis. As Mexico during the 1980s, Chile during the 1970s undertook major structural reforms characterized by a drastic opening of the economy, a sweeping privatization program and a major deregulation effort aimed at creating a modern financial sector. In Chile, as in Mexico more than a decade later, the use of a predetermined exchange rate to eliminate inflation, combined with very large capital inflows that were intermediated by a weak banking system, generated a situation of exchange-rate overvaluation, a

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vulnerable financial sector and eventually the collapse of the currency. What makes the comparison of these two crises particularly interesting is that, as events unfolded and many economic indicators worsened, the authorities in both countries resorted to optimistic rhetoric, arguing that everything was well, and that their nations were experiencing the "best of times". Many policy decisions that helped generate and deepen the crisis of 1994 could have been avoided if Mexican officials had paid closer attention to the economic history of Chile.

This paper provides a comparative analysis of some macroeconomic aspects of the Chilean and Mexican crises. The discussion emphasizes a question of increasing concern in policy circles throughout the developing and transitional economies: to what extent are exchange-rate-based stabilization programs successful in reducing -- or even eliminating -- inflationary inertia? The importance of this issue resides on the fact that many analysts had praised the Mexican stabilization program arguing that, in the presence of incomes policies -- such as the ones implemented by the Mexican *Pacto* -- a stabilization program based on an exchange-rate anchor would not generate an exchange-rate overvaluation, allowing the economy to rapidly reduce inflationary inertia with no (or very small) side costs.

The paper is organized as follows: in section I, I provide a brief overview of the Chilean and Mexican reform and stabilization programs, initiated in 1975 and 1985. In section II, I develop a theoretical model on the effects of exchange-rate-based stabilization programs on inflationary inertia. The model emphasizes the roles of government preferences and credibility. In section III, I use detailed data on Chile and Mexico to assess whether these programs affected the time series properties of inflation; more specifically, I investigate whether they reduced inflationary inertia. In section IV, I provide some concluding remarks, including some thoughts on the effects of capital inflows on the equilibrium real exchange rate in both cases. I argue that the magnitude of real exchange-rate appreciation observed in both countries in the period preceding the crises is highly unlikely to be the result of an "equilibrium" phenomenon justified by "fundamentals". I further argue that in both countries the real exchange rate became badly

overvalued, and that to a large extent, the respective crises were the consequence of this overvaluation.[1]

I. The Chilean and Mexican Reform and Stabilization Programs: A Comparative Overview

The Chilean reform program was initiated in 1975, ten years prior to the launching of the Mexican reforms. Nevertheless, both programs shared a number of features: (a) drastic opening of the economy; (b) ambitious privatization and deregulation; and stabilization based on a predetermined, nominal exchange-rate anchor, supported by (largely) restrictive fiscal and monetary policies. Table 1 contains a comparison of the policies undertaken in both countries.[2]

Both programs were rooted in the notion that a predetermined rate of nominal devaluation -- including a fully fixed nominal exchange rate -- would constrain price increases, reduce inflationary expectations and ensure that monetary and fiscal authorities would behave conservatively. In Chile, the exchange-rate-based stabilization program had two phases: the first one went from February 1978 through June 1979, and was characterized by a preannounced rate of devaluation deliberately set below the ongoing rate of inflation. In June of 1979, and in light of very slow progress in reducing inflation, the nominal exchange rate was pegged at 39 pesos per dollar. The authorities announced that this new exchange rate would be in effect for the "indefinite" future.

The Mexican program followed a somewhat different pattern. In early 1988, the nominal exchange rate was fixed, becoming the fundamental anchor of the antiinflationary

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[1] For an elegant, theoretical illustration of different causes or varieties of capital-market crises, see Calvo (1995).

[2] On the Chilean reforms, see Harberger (1985), Edwards and Edwards (1991) and Bosworth et al. (1994). On the Mexican experience, see Dornbusch (1988), Dornbusch and Werner (1994), and Calvo and Mendoza (1995). For an analytical review of several stabilization experiences with moderate inflation, see Dornbusch and Fischer (1993).

Table 1: The Chilean and Mexican Structural Reforms: An Overview

	CHILE	MEXICO
Approximate date of reforms initiation	1974-1975	1985-86
Trade Liberalization	Major unilateral opening during 1975-79. All quantitative restrictions eliminated; uniform import tariff of 10% established. Temporary hike in tariffs in mid 1980s; since 1987 uniform import tariff of 11%.	Significant reform initiated in 1985. In 1986 joined GATT. Coverage of nontariff barriers reduced from 90% of imports in 1986 to 19% of imports in 1994. Tariff range reduced to 0-20%, with a tariff average of 13% in 1994. In 1994 joined NAFTA.
Privatization	Two rounds of privatization: 1974-79 and 1984-89. During first round banks were privatized first, followed by manufacturing firms. First round ended in crisis in 1982 with a number of major banks being nationalized. During second round effort was made to establish regulatory framework before firms and banks were sold. By 1994 all but a handful of firms had been privatized. By that time approximately 96% of state owned enterprises had been privatized. Some major firms, including the giant copper producer CODELCO remains under government control.	Major privatization program started in 1984 and intensified in 1989. Small manufacturing firms privatized first, public utilities next, followed by banks. Effort made to implement modern regulatory framework. In spite of this, regulation and supervision remained weak, especially in the banking sector. Effort to assign individual property rights on land has been significantly slowed down by legal and logistical difficulties. By 1994 approximately 80% of state owned enterprises had been privatized. Oil related firms -- including PEMEX-- remained in the government sector.

Table 1, continued.

	CHILE	MEXICO
Fiscal Reform	Major tax reform in 1975. Value added tax introduced. Personal and corporate income taxes consolidated. Significant improvement in administrative capacity. Fiscal accounts balanced since 1977. Tax rates revised in mid 1980s in order to encourage savings.	Tax reform initiated in 1985. Major adjustment accomplished -- primary fiscal deficit of 6% of GDP was transformed into surplus exceeding 7% of GDP. Fiscal stance was somewhat loosened in 1994 as the presidential elections approached.
Financial Reform	Sweeping reform was begun in 1975 with privatization of banks. Interest rate controls and forced credit allocation were eliminated. Reserve requirements were drastically reduced and entry into the banking sector was encouraged. Securities markets received a major boost as a result of social security reform. Supervisory framework weak until mid 1980s; significantly strengthened since then.	Important reform initiated in 1988, when interest rates were freed. Some directed credit and subsidized loans still handled by development banks. Banks gradually privatized after 1990. Reserve requirements fully eliminated on peso-denominated deposits. Banks allowed to hold equity positions in manufacturing and other firms. Regulatory and supervisory capacity weak.
Social Security	Insolvent pay-as-you-go system replaced by individually capitalized system run by private administrators. Health system transformed into a two-tier system: a basic one for lower income people and an insurance-based system for most workers.	No significant reform until 1994.

Table 1, continued. 6

	CHILE	MEXICO
Labor Markets	Reformed in 1981. Severance payments capped, conflict resolution system redesigned. Taxes on labor reduced significantly. Most barriers to entry eliminated. Labor legislation reformed in 1991, but main features of 1981 reform maintained.	No significant action as of 1994.

Source: Edwards and Edwards (1991) and Edwards (1995).

effort.[3] Between 1988 and 1994, Mexico modified its exchange rate-based stabilization program several times. From February to December of 1988 a completely fixed rate with respect to the US dollar was adopted; between January 1989 and November 1991 a system based on a preannounced rate of devaluation was in effect. During this period the actual rate of devaluation was deliberately set below the ongoing rate of inflation as a way of reducing expectations and price increases. The amount by which the peso was devalued was successively reduced from one peso per day in 1989, to 80 cents in 1990, to 40 cents in 1991 and to 20 cents in 1991 -- see table 2. In November 1991 the authorities decided to add some flexibility to the system, and an exchange rate band with a sliding ceiling was adopted. This measure was justified on two grounds: (a) it was supposed to discourage short term capital inflows; and (b) it was supposed to allow some real exchange rate corrections (Banco de Mexico, 1993). As figure 1 shows, until October 1993 -- when the NAFTA controversy heated up in the United States -- the actual peso/dollar rate was extremely stable, remaining in the lower half of the band. During 1994, however, and as a result of political and other developments, the exchange rate came under considerable pressure, moving towards the top of the band. As is well known, the attempt to widen the band in late December failed badly, precipitating the crisis.

From early on, Chilean and Mexican authorities understood that a precondition for the the success of the exchange-rate-based stabilization programs was that fiscal and monetary policies had to be consistent and supportive. In fact, in both countries the primary balance of the public sector was under control even before the adoption of the exchange-rate anchor, and monetary policy was largely restrained during most of the period.[4]

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[3] During October-December 1987, the first months of the *Pacto*, nominal wages provided the anchor to the system. According to Vela (1993) the move to an exchange-rate anchor in February 1988 was, in part, the result of labor union pressure.

[4] During the early years of the Mexican program, monetary policy was guided by a dual objective: on the one hand the authorities were interested in reducing interest rates -- which had reached extremely high real levels in 1987 and 1988 --, and on the other hand they wanted to make sure that domestic credit policy would be consistent with the predetermined nominal exchange rate (Aspe 1993, p. 37). An analysis of monetary policy in Mexico using a

Table 2. Exchange Rate Policy

A. Chile, 1975 - 1982

April 1975 - May 1976	Crawling peg: nominal exchange rate adjusted at approximately the same rate as lagged inflation
June 1976 - January 1978	Crawling peg continued, but with 10% revaluations on June 1976 and March 1977
February 1978 - June 1979	The *tablita* system: preannounced rates of devaluations set below the ongoing rate of inflation
June 1979 - June 1982	Fixed peg set at 39 pesos per dollar

B. Mexico, 1988 - 1994

February-December 1988	Fixed nominal exchange rate at 2281 pesos per dollar
January-December 1989	Preannounced rate of devaluation set at 1 peso per day
January-December 1990	Preannounced rate of crawl of nominal exchange rate set at 80 cents per day
December 1990-November 1991	Preannounced rate of crawl of nominal exchange rate set at 40 cents per day
November 1991-October 1992	Exchange rate band adopted. Floor is fixed at 3050 pesos per dollar, while ceiling slides at 20 cents per day
November 1992-December 19, 1994	Rate of devaluation of band's ceiling is accelerated to 40 old cents per day (0.0004 new pesos). Bank of Mexico intervened through March 1994 in order to maintain the dollar/peso rate within narrower (confidential) "inner" band
December 20-December 21, 1994	Ceiling of band increased by 15 percent
December 22, 1994 onwards	Floating exchange rate

Fig. 1.a. Nom. Exch. Rates and Bands
End of period, Monthly

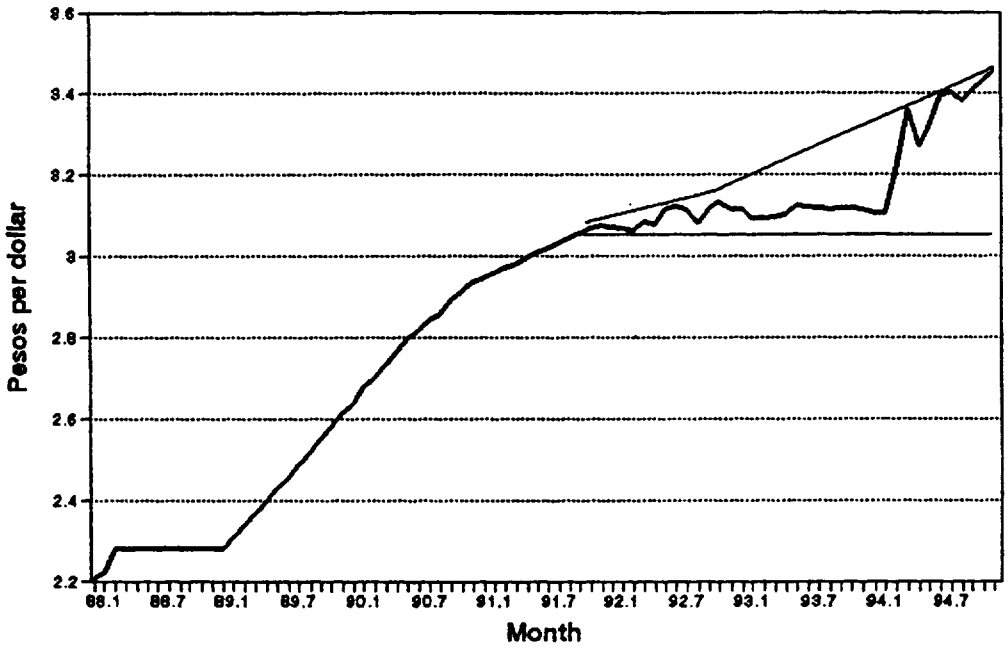
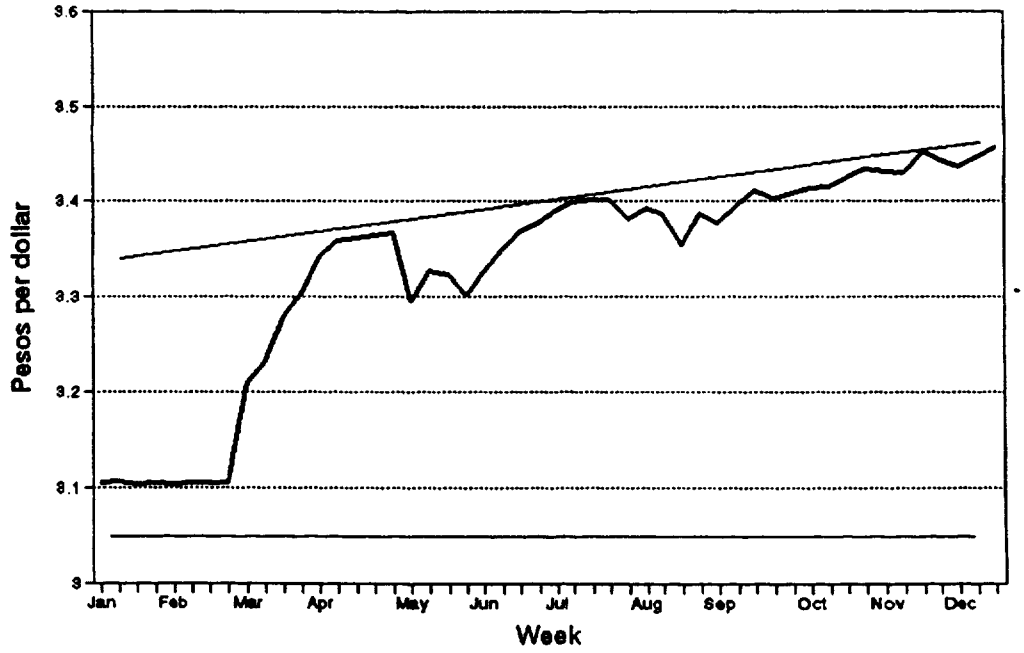


Fig. 1.b. Nom. Exch. Rate, 1994
End of period, Weekly



The architects of these measures expected that the exchange-rate based stabilization program would operate through, at least, two channels. First, in an open economy a fixed exchange rate would impose a ceiling to tradables inflation; second, the new exchange rate policy was expected to generate a major break in inflationary expectations. This view was clearly captured by Chile's finance minister in February 1978, when he stated that:

> "[T]he openness of the economy to international trade and the preannouncement of the rate of devaluation...will rapidly generate competitive imports for those domestic products whose internal prices are increased above reasonable levels..." (De Castro 1978, p. 241).

And then he went on to say:

> "[T]he exchange rate policy has provided a reasonable orientation to inflationary expectations on the part of the public, because it is solidly supported by the absence of the need for money creation..." (Cited in Mendez 1979, p. 287).

Along similar lines, Mexico's finance secretary Pedro Aspe pointed out that:

> "[Pegging the exchange rate] and...lowering... trade barriers in the tradables sector were indispensable for breaking down inertia. Consensus and a tendency toward purchasing power parity could reinforce each other to bring down inflation" (Aspe 1993, p. 44).

Despite these similarities, there were important differences between the Chilean and Mexican programs. Perhaps the most important one was that Chile's stabilization program did not rely on any type of price or wage controls. In fact, beginning in 1976, Chile adopted a formal backward looking wage indexation scheme, through which all wages in the formal sector were periodically raised to compensate for the cumulative rate of inflation of the previous period (Edwards and Edwards 1991, Ch. 6). In contrast, the Mexican *Pacto*

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methodology suggested by Harberger and Edwards (1981) indicates that the Banco de México engaged in sterilized intervention at various times during 1988-93.

encompassed a social and economic agreement among the government, the private sector and labor unions, and became a fundamental feature of the program. On an annual basis, and partially based on forward looking expectations, the *Pacto* established guidelines for price, wage, and exchange rate changes. The renewal of the *Pacto* was always a major event, surrounded by anticipation and, at times, by anxiety.

As their reforms proceeded and became consolidated, both countries were subject to very large capital inflows (figure 2) which helped finance increasingly large current account deficits. In Chile the current account deficit exceeded 12% of GDP in 1981, while in Mexico it surpassed 7% of GDP both in 1992 and 1993.

As figure 3 shows, in both countries the stabilization programs succeeded in bringing inflation down. In the process, however, the real exchange rate appreciated significantly. An important question, both at the time of the programs and in post-mortem analyses, has been whether these real appreciations were justified by "fundamentals" –and especially by massive capital inflows –, as the authorities in both countries argued or whether, as the critics pointed out, they represented a disequilibrium situation.[5]

In 1988-89, independent analysts and the architects of the Mexican stabilization program, were clearly aware of the dangers of the real appreciation syndrome -- an eventual overvaluation -- associated with exchange-rate-based stabilization programs. For example, in an early analysis of the Mexican program, Dornbusch (1988, p. ?) argued that "[t]he risk is that when inflation has disappeared it has been replaced by a new problem such as exchange rate overvaluation or bankruptcies". The Mexican authorities, however, argued that there were two reasons why Mexico would be exempted from this fate. First, the policy was initiated in the context of exchange rate *under*valuation, that is, there was a built-in "cushion" for the real exchange rate to appreciate without hurting the external position of the country.

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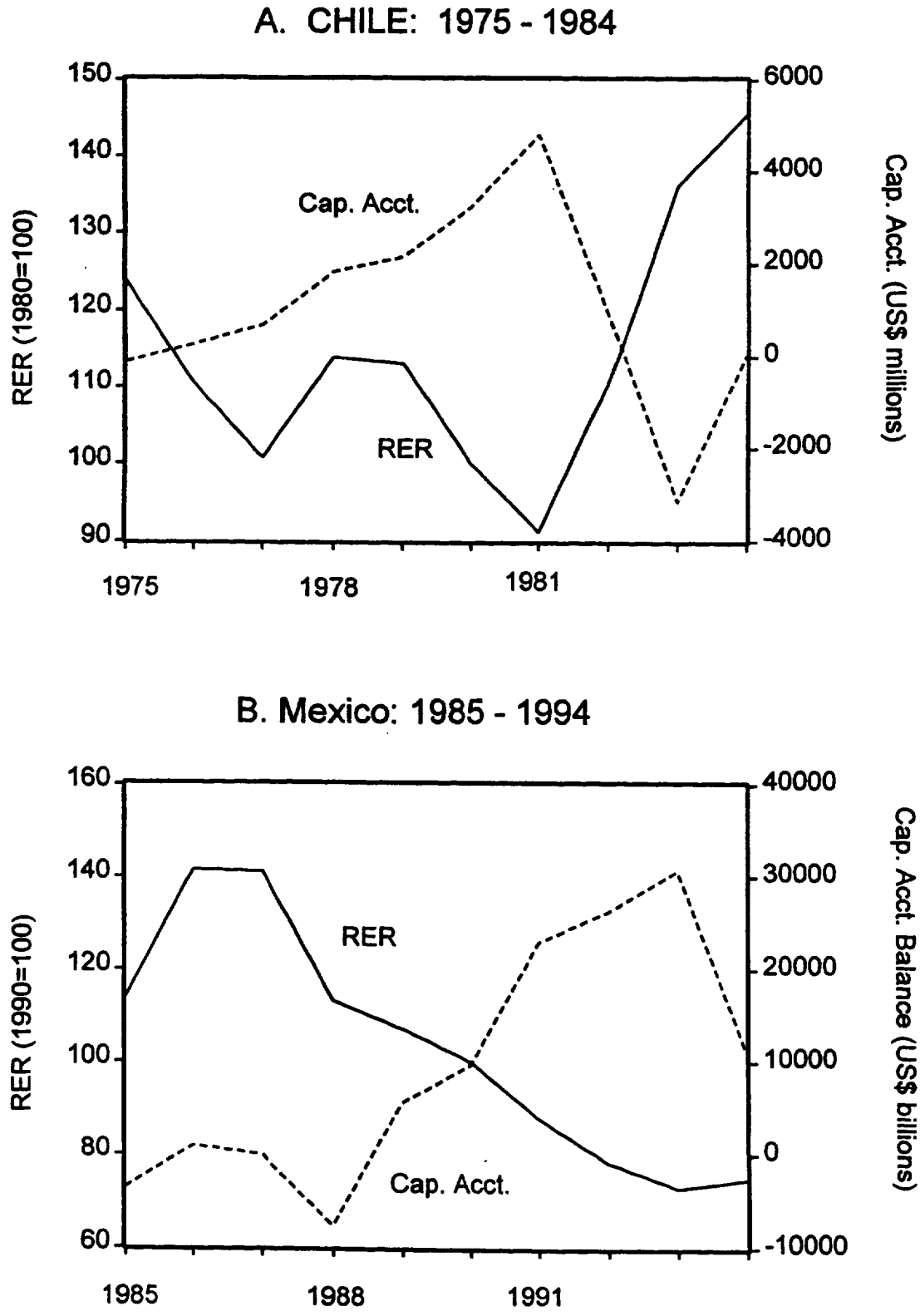
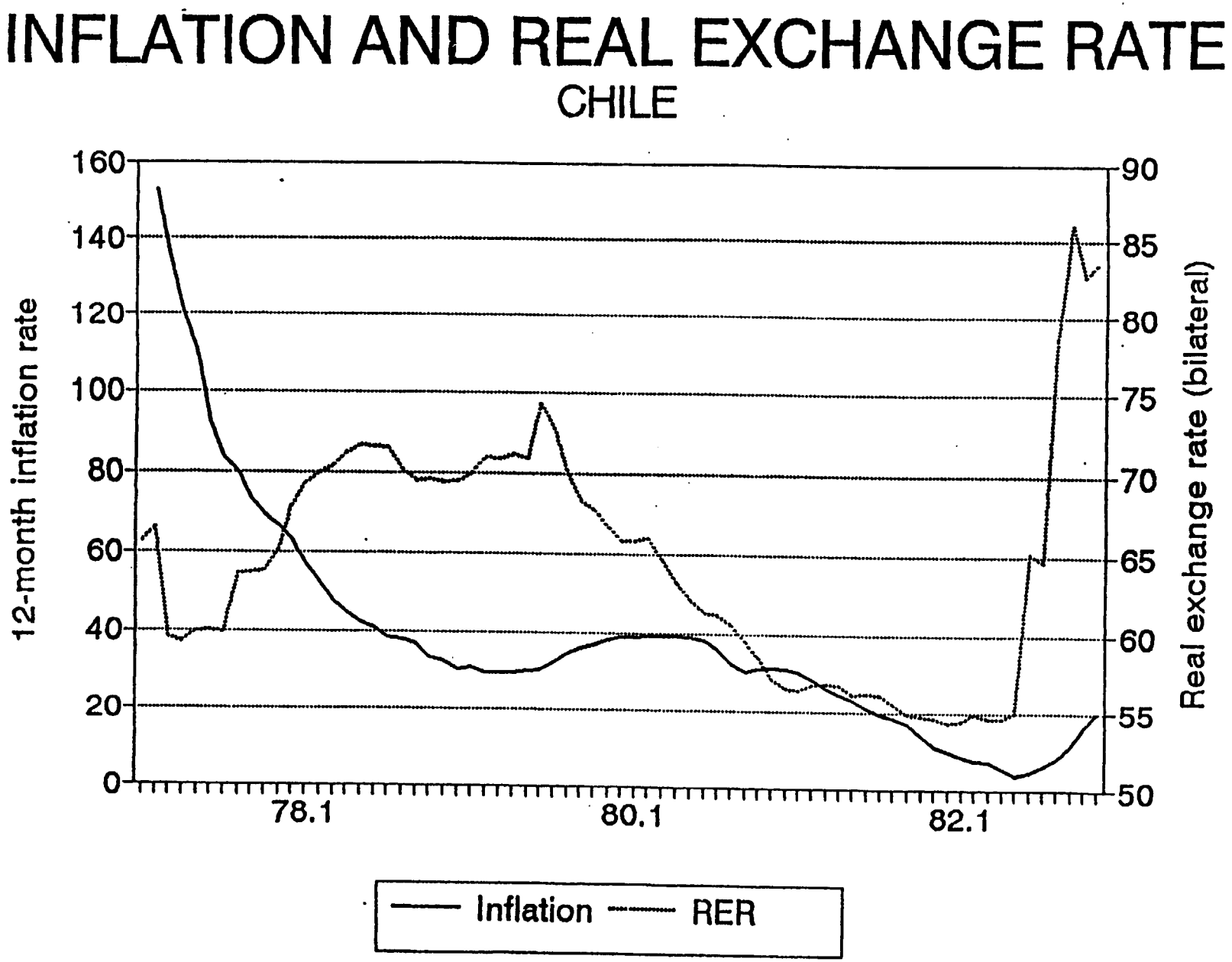
[5] For accounts of the controversies that emerged during the implementation of both programs, see Edwards and Edwards (1991) and Dornbusch et al. (1996).

Figure 2. Capital Account Balance and Real Exchange Rates



Source: IMF, International Financial Statistics.

Figure 3.a. Mexico: Inflation and Real Exchange Rate



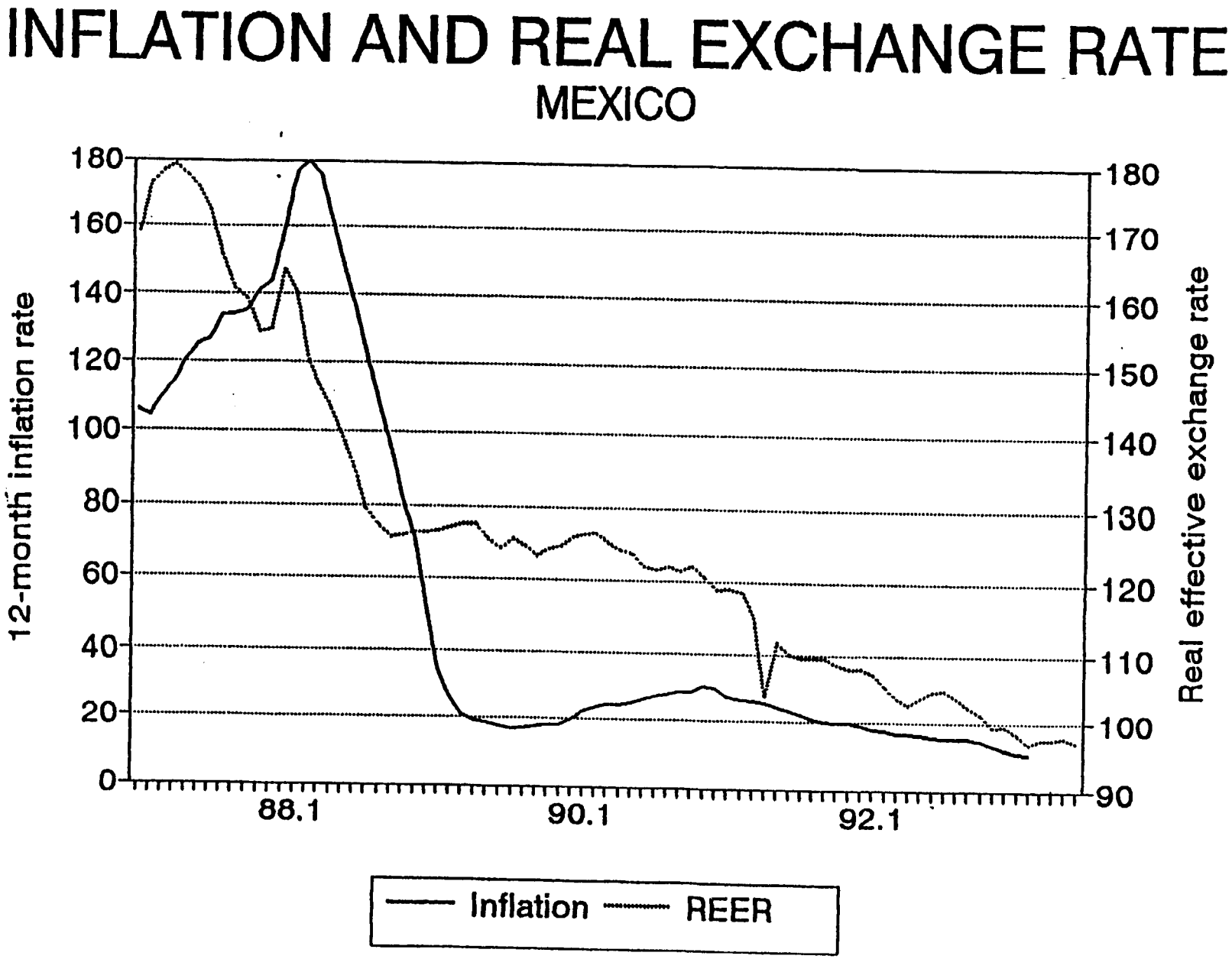


Figure 3.b. Mexico: Inflation and Real Exchange Rate

Second, Mexico had ample international reserves.[6] Addressing Congress on March 10, 1988, Minister Aspe said that "...for the exchange rate to serve [as an anchor]...it is required that the balance of payments start from a favorable surplus position...[T]he use of the exchange rate according to a downward tendency ...is fully justified if we consider that there is an ample margin of undervaluation of our currency" (cited in Vela 1993, p. ?).

II. Exchange-rate Anchors and Inflationary Inertia

Exchange-rate-based stabilization programs have usually been adopted as a way of reducing -- or better yet, eliminating -- the degree of inflationary inertia in countries suffering from rapid inflation. For instance, in explaining the Mexican stabilization effort, Secretary Aspe (1993, p.42) explained that the purpose of the *Pacto*, including the exchange rate policy, was to "reduce inertial inflation." The speed at which inertia is actually reduced is important; under fixed exchange rates, a very slow decline in inertia will end up generating a process of acute real exchange rate overvaluation, that could end up placing the whole stabilization program in jeopardy.

In countries adopting an exchange-rate-based stabilization program the initial conditions are usually characterized by ingrained indexation and high inflationary inertia. Under these circumstances it is common for an accommodative monetary policy to help maintain inflation. A crawling peg exchange-rate policy, where the currency is periodically devalued in proportion to domestic and international inflation differentials, is a central component of this rapid inflation equilibrium. The purpose of this policy is to avoid the erosion of the real exchange rate and international competitiveness. In this setting, the adoption of an exchange-rate anchor represents a fundamental change in the exchange-rate regime, and its success in bringing down inflation will be directly affected by the credibility of the policy shift. If the public truly believes that the authorities preferences have changed and the new regime is permanent, inflationary inertia is

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[6]Later, two additional explanations would be added to this list: NAFTA would provide enough capital to sustain a more appreciated real exchange rate, and productivity gains would offset the real exchange rate appreciation (Aspe 1993).

likely to decline very rapidly; on the other hand, if private agents doubt the authorities' commitment to the new exchange-rate regime, inflationary inertia will barely be affected by the new policy.

There are several possible ways of formally introducing inertia into an inflation model.[7] Perhaps the most common one is assuming the existence of staggered contracts. In this section, however, I take an alternative approach. I initially assume that wages are set in a rational and forward looking way. I assume, however, that economic authorities follow an exchange rate target policy characterized by the adjustment of the nominal exchange rate by (a proportion of) lagged differentials between domestic and international inflation. This type of exchange rate targeting policy has, in fact, been followed historically by a number of countries, including Argentina, Brazil, Chile and Colombia.[8] In subsection II.3, however, I briefly explore alternative sources of inertia, including staggered contracts.

Consider the case where, the authorities dislike both real exchange rate misalignment and inflation. More specifically, assume that the authorities try to minimize the following loss function:

$$\min L_t = \mu\, \pi^2 + (1 - \mu)\, \{s^I_t - s^*_t\} \tag{1}$$

where, s^I is an index of the real exchange rate, and s^* is the equilibrium real exchange rate. The parameter μ reflects the (relative) weight that the authorities attach to inflation in their loss function. A low value of μ means that the authorities care mostly about avoiding real exchange rate misalignment, and will tend to follow a real exchange rate targeting type of policy.

In most historical cases of real exchange rate targeting the authorities focus on a real exchange rate index of the following type:

$$s^I_t = S_t\, (P^*_{t-1} / P_{t-1})^{\theta} \tag{2}$$

where S_t is the spot nominal exchange rate, and θ (≤ 1) is a parameter that determines the importance of relative price levels in the conduction of nominal exchange rate policy. If $\theta < 1$,

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[7] See Bruno (1991).

[8] On alternative historical experiences with crawling peg regimes, see the essays in Williamson (1981).

the authorities will tend to correct the nominal exchange rate by less that inflation differentials. P^* is the foreign price level and P is the domestic price level. Notice that if I=0 and $\theta = 1$, this expression corresponds to the traditional contemporaneous real exchange rate index. In most countries, however, price indexes are known with some time lag, and prices in the previous period are used to implement the real-exchange-rate targeting policy. In the rest of this subsection I assume then that I=1; in the extensions discussed above, however, I consider the case where I=0, and the authorities base their real exchange rate target policy on the expected price ratio.

The rest of the model is given by equations (3) through (9):

(3) $$\pi_t = \alpha \pi_{Tt} + (1 - \alpha) \pi_{Nt},$$

(4) $$\pi_{Nt} = \beta_1 \omega_t + \beta_2 \delta_t + \beta_2 \pi^*_t + \beta_3 \dot{z}_t$$

(5) $$\beta_1 = \epsilon / (\eta + \epsilon); \ \beta_2 = \eta / (\eta + \epsilon); \ \beta_2 = -\kappa / (\eta + \epsilon);$$

(6) $$\pi_{Tt} = \delta_t + \pi^*_t$$

(7) $$\omega_t = E(\pi_t).$$

(8) $$d \log s^*_t = x_t$$

(9) $$\dot{z}_t = d\log m_t - d\log m^d_t$$

Equation (3) is the rate of inflation defined as a weighted average of tradable (T) and nontradable (N) inflation. Equation (4) is the rate of nontradables inflation, which depends on the rate of growth of wages ω, the rate of devaluation δ, the rate of world inflation π^*, and the rate of excess supply for domestic liquidity $\dot{z}$. This expression is derived from the equilibrium condition for the nontradable market and, thus, the β parameters are related to the demand and supply elasticities of nontradables, and are given by equation (5) -- η (<0) is the price demand elasticity of nontradables, κ is the expenditure elasticity of demand for N, and ϵ (<0) is the real product price supply elasticity of nontradables.[9] Equation (6) is tradables inflation, and is given by the law of one price. Equation (7) governs the rate of growth of wages. It is assumed that workers want to maintain the real value of their wages and, thus, that wage increases will be equal to expected inflation -- below, however, I discuss the case of partially backward looking indexation.

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[9] See Edwards (1995).

Equation (8) is the change in the equilibrium real exchange rate, where x_t is a random terms of trade shock distributed $N(0, \sigma^2)$, and assumed to be observed before the authorities determine exchange rate policy. Finally, equation (9) states that excess liquidity is equal to the excess (flow) supply of domestic money. In the empirical analysis (section III) I use several alternative definitions of excess liquidity.

II.1 Crawling Peg and Inertial Inflation

Consider the case of an economy with a rapid ongoing rate of inflation -- say, in the high two or low three digits level --, where the authorities' only concern is avoiding real exchange rate overvaluation -- that is $\mu = 0$ in equation (1). Assume, further, that wages are set before other contemporaneous variables are observed, and that exchange rate policy is determined before domestic and international inflation rates are known. In this case the optimal nominal exchange rate policy is given by the following real-exchange-rate-target devaluation rule (this assumes, as above, that I=1):

$$\delta_t = \theta (\pi_{t-1} - \pi^*_{t-1}) + x_t. \tag{10}$$

This type of crawling peg rule historically has been pursued by a large number of countries with a rapid rate of inflation -- the nominal exchange rate is adjusted by a proportion θ of lagged inflation differentials, corrected by changes in real exchange rate fundamentals. A special -- and yet very common case -- emerges when $\theta=1$ and when the rate of devaluation is set before the real shock is observed. In this case $\delta_t = (\pi_{t-1} - \pi^*_{t-1})$; the rate of nominal devaluation is strictly equal to past inflation differentials (Williamson 1981).

Assuming that expectations are formed rationally, the dynamics of inflation is given by[10]:

$$\pi_t = \theta \pi_{t-1} - \theta \pi^*_{t-1} + \pi^*_t + \lambda \dot{z}_t + \phi_t . \tag{11}$$

Where $\lambda > 0$, is a function of the parameters of the model, and ϕ_t is an iid random term. Equation (11) implies that inflation will tend to exhibit persistence. Since under a crawling peg regime monetary policy is accommodative, in the steady state, $\dot{z} = 0$, and domestic inflation will

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[10] In the case of wages, this means that the structure of the model is used to compute $E(\pi)$. Since the model does not have enough structure, in the case of international inflation and demand pressures, this means that actual (observed) variables deviate from expected values by an iid random term.

converge to world inflation, as long as $\theta<1$. The speed at which this convergence takes place will, of course, depend on the value of θ: a higher θ will result in a slower convergence process. Notice that if there is full backward exchange rate indexation -- that is, if $\theta=1$ -- the domestic rate of inflation will have a unit root and the economy will have no anchor. In this case, either demand or real shocks could eventually generate *any* level of domestic inflation.

II.2 Nominal Exchange-rate anchor and Stabilization

The adoption of an exchange-rate-based stabilization program can be interpreted as being the result of a change in the authorities' preferences; from paying very little (or no) attention to inflation, to placing a high priority on it. More specifically, consider the case where at some point in time there is a complete switch in preferences. At that time the authorities announce that they now attach a value of one to μ in the loss function (1). In this case the optimal devaluation rule is to maintain a fixed exchange rate:

(12) $$\delta_t = 0.$$

The dynamics of inflation, however, will depend on the degree of credibility of the new policy. It is possible that the public will have some doubts on what the new regime will be -- either a genuinely fixed rate system, or a pegged exchange-rate regime with an escape clause. In the latter case the public will assume that there is a positive probability that the authorities will abandon the pegged rate and will revert to the old regime. This probability measures the degree of credibility of the stabilization policy; a value of one would mean full credibility, while a value of zero would mean complete absence of credibility. If the public's perceived probability that the pegged exchange rate policy being maintained is denoted by q, the dynamics of inflation will be:

(13) $$\pi_t = (1 - q)\,\theta\,\pi_{t-1} - (1 - q)\,\theta\,\pi^*_{t-1} + \pi^*_t + \lambda\,\dot{z}_t + \phi_t .$$

Under full credibility ($q = 1$), and monetary equilibrium ($\dot{z}_t = 0$), inertia will disappear and domestic inflation will be immediately equal to world inflation (plus a random term).

Notice, however, that even under less than full credibility ($0<q<1$) the adoption of an exchange-rate-based stabilization program will reduce the degree of inflationary inertia, accelerating the convergence of domestic inflation toward international inflation. A slow rate of convergence, however, will result in a process of real-exchange-rate appreciation that, depending

on the initial conditions of the economy, will eventually be translated into real-exchange-rate overvaluation. More specifically, assuming that monetary policy is aimed at satisfying changes in the demand for money (that is $\dot{z}_t = 0$) the dynamics of the real exchange rate -- $s_t = S_t (P^*_{t-1} / P_{t-1})$ -- will be given by:

$$d \log s_t = - (1 - q) \theta (\pi_{t-1} - \pi^*_{t-1}) - \phi_t . \quad (14)$$

Since, by definition, this economy originally has a domestic rate of inflation that exceeds world inflation (that is $\pi_{t-1} > \pi^*_{t-1}$), there will be a continuous real appreciation until domestic and international inflations converge.

Notice that in the case of an exchange-rate-based program, the authorities can still manipulate monetary policy in order to move closer to the inflationary target. More specifically, equation (13) suggests that in the absence of full credibility ($q<1$) the authorities can implement a restrictive monetary policy -- $\dot{z}_t < 0$ -- in order to reduce inflation. In fact, in a more general model of the degree of credibility, q would be endogenous and, in principle, would be affected by the monetary stance taken by the authorities. The model developed here does not have, however, enough structure as to fully model the optimal degree of monetary contraction for given levels of exchange rate policy credibility, nor to endogenize the degree of credibility. In the empirical section, however, I explicitly allow the degree of credibility to vary through time.

In order to analyze empirically the degree of effectiveness of an exchange-rate-based stabilization program, an inflation equation of the type of (13) can be estimated using time series data. If the program is credible a break in the inflationary process should be detected, with a significant reduction in the coefficient of lagged inflation. In contrast, if the program is not credible, the inflationary process would not experience a structural change at the time the exchange-rate anchor is adopted. Tests along these lines for Chile and Mexico are reported in section III below.

II.3 Alternative Sources of Inflationary Inertia

The analysis presented above has assumed that wages are set in a rational and forward looking fashion -- recall equation (7) -- and that inertia is the result of a backward looking exchange rate policy. This, of course, is not the only way of generating a persistent inflationary process. It is possible, in fact, to reverse this assumption and still obtain inertial inflation.

Consider, for example the case where some wages are set in a multi period, staggered fashion.[11] The aggregate wage equation will, then, have a backward as well as a forward looking component (Obstfeld 1995). In particular, consider the following wage rate equation:

(7') $$\omega = \rho\ \pi_{t-1} + (1 - \rho)\ E(\pi_t),$$

where ρ is the degree of backward indexation. If $\rho = 1$ there is full backward looking indexation, as was the case in Chile between 1977 and 1982. Assume further that under the crawling peg regime, instead of focusing on lagged inflation differentials, the authorities devalue the nominal exchange rate in a proportion θ of *expected* inflation differentials. The devaluation rule (10) then becomes:

(10') $$\delta_t = \theta\{ E(\pi_t) - E(\pi^*_t) \} + x_t.$$

In this case inflation will still exhibit inertia. The autoregressive term in the inflation dynamics equation, however, will be more complicated than before and will depend on the structural parameters of the model, including θ and ρ. In this case the extent to which the adoption of an exchange-rate anchor will reduce inertia will depend both on the degree of credibility of the new policy, and on the weight of backward looking indexation in the aggregate wage rate equation (7'). Even if the new policy is fully credible (and, thus, q=1), inertia will remain as long as a proportion of wages are set in a staggered fashion ($\rho>0$). If, however, once the policy shift occurs and the nominal exchange rate is pegged, all wage contracts are set in a rational and forward looking fashion, inertia will cease and domestic inflation will immediately converge to international inflation.

III. Exchange-rate Anchors and Inflationary Inertia in Chile and Mexico

The success of an exchange-rate-based stabilization program will depend on the extent to which inflationary inertia is reduced. The program will be highly successful if inertia is rapidly (or better yet, instantaneously) eliminated. As suggested by the model, this requires a credible shift in nominal exchange rate policy -- that is a (very) high value of q -- and the absence (or

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[11] On the role of staggered contracts and its implications for economic policy, see Fischer (1986).

elimination) of backward looking indexation of other contracts, including wages. On the other hand, the program will be a failure if inertia remains largely unaffected after the adoption of the exchange rate nominal anchor. In this case the real exchange rate will become increasingly overvalued while inflation will continue its pre-program path.

Some authors, including Edwards (1993), Vela (1993) and Santaella and Vela (1995), have used interactive dummies to investigate the credibility of the Mexican program. These authors found that the coefficient of lagged inflation experienced a significant reduction after the adoption of the *Pacto* program. A limitation of this approach, however, is that it assumes that after the program is implemented the degree of credibility, and thus of inertia, remains constant. This, of course, need not be the case. Clearly, the degree of credibility -- measured by parameter q in the model in section II -- can change through time affecting the degree of persistence of inflation. It is perfectly possible, for example, that an exchange-rate-based program begins with a low degree of credibility, only to become increasingly credible through time. In this case we would expect that the coefficient of lagged inflation will not be immediately affected, but that it will decline as the program proceeds.

In this section I use a battery of tests to investigate whether in Chile and Mexico the adoption of the exchange-rate-based stabilization program was credible and, thus, eventually reduced the degree of inflationary inertia. I begin by estimating inflation dynamics equations of the form of (13) on a number of price indexes using recursive coefficient techniques. If inertia is reduced it is expected that the coefficient of lagged inflation will decline through time; whether this decline is fast or slow will depend on how rapidly credibility gets ingrained. I also analyze whether the time series of inflation exhibit a structural break at (approximately) the time when the nominal exchange-rate anchor was adopted. Third, I use two model-free approaches to look at the evolution of persistence through time: I compute autocorelation coefficients for a number of subperiods, and I estimate Cochrane's (1988) variance ratio statistic to inquire whether the extent of inertia declined after the stabilization programs were implemented.

III.1 Data

I use both quarterly and monthly data inflation rates. For Chile I looked at different sub periods between 1974 and 1982, while in the case of Mexico I concentrated on 1982 through

1994. In both cases I analyzed the behavior of consumer price indexes and its disaggregated components, as well as that of producer price indexes. The analysis of disaggregated data permits, in principle, to distinguish different types of goods that exhibit different degrees of inflationary inertia. The exact data sources are provided in the appendix.

Monetary pressures were proxied by two variables. First, a measure of excess supply of domestic credit was estimated by:

$$EXCRE = d \log DC - d \log Y,$$

where DC is domestic credit and Y is a moving, average index of nominal industrial production, used as a proxy for aggregate income. This definition assumes that the income elasticity of the demand for domestic credit is unitary. Second, an index of excess supply of money (M2) was obtained from the residuals of a demand for money equation.[12] This variable is denote by EXMO. While in the estimates for Mexico I used both EXCRE and EXMO, in the case of Chile I was forced to concentrate on EXMO, due to data availability problems.

III.2 Recursive Coefficient Estimates

Quarterly data were used to estimate equations of the type of (13) using recursive coefficient techniques. Quarter to quarter changes in CPIs and PPIs were used as dependent variables; international inflation was proxied by quarterly changes in the US's producer price index; and, as pointed out above, EXCRE and EXMO were used as measures of aggregate demand pressures. Figure 4 reports the recursive coefficient estimates for lagged PPI and CPI inflation in Chile and Mexico. In the case of Mexico, these coefficients were obtained using EXMO as the aggregate demand pressures variable; when alternative indicators were used, the results obtained were very similar.

Several interesting findings emerge from this figure. First, there is no evidence of a reduction in the degree of inflationary inertia in Chile after the exchange-rate-anchor program was implemented in 1978, nor when it was modified -- and a strict fixed nominal exchange rate was adopted -- in June of 1979. Moreover, the figure suggest a gradual increase in the (point)

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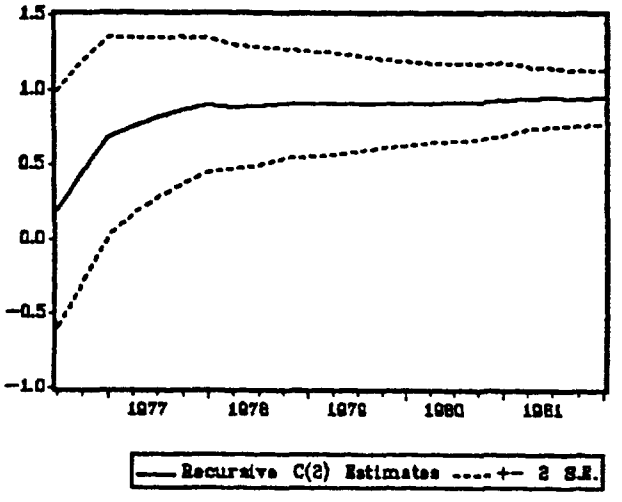
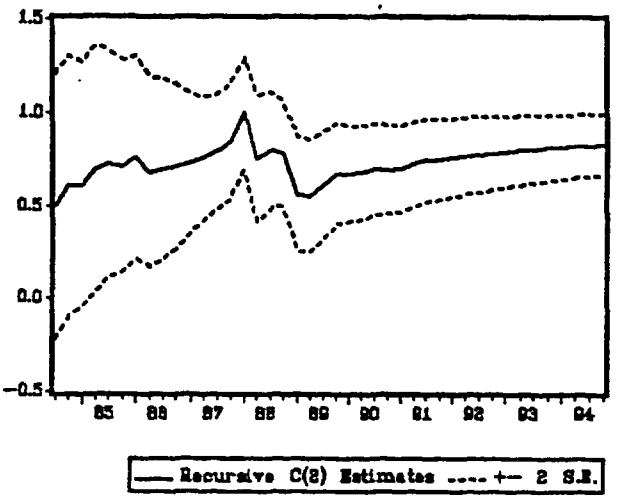
[12] In the case of Mexico, I allowed for currency substitution in the estimation of the demand for money.

Figure 4. Recursive Coefficient Estimates for Lagged Inflation

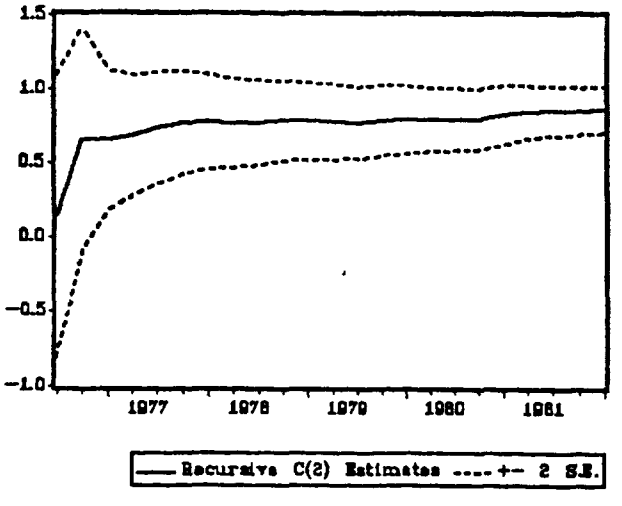
A. Chile: CPI Inflation



A. Mexico: CPI Inflation



B. Chile: PPI Inflation



B. Mexico: PPI Inflation

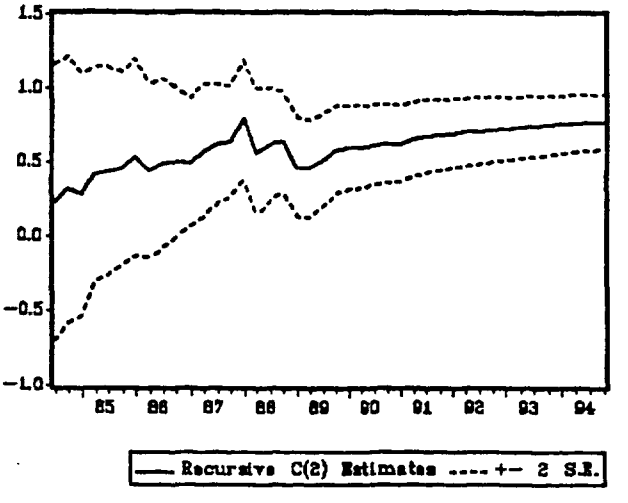


Table 3: Tests for Stability of Inflation Regressions, Chile and Mexico

	χ^2
A. CHILE	
A.1. CPI inflation; 1978.2 break point	1.59 (0.90)
A.2. CPI inflation; 1979.3 break point	1.17 (0.95)
A.3. PPI inflation; 1978.2 break point	2.49 (0.78)
A.4. PPI infltaion; 1979.3 break point	2.37 (0.80)
B. MEXICO	
B.1. CPI inflation; 1988.1 break point	13.90 (0.02)
B.2. PPI inflation; 1988.1 break point	11.40 (0.04)

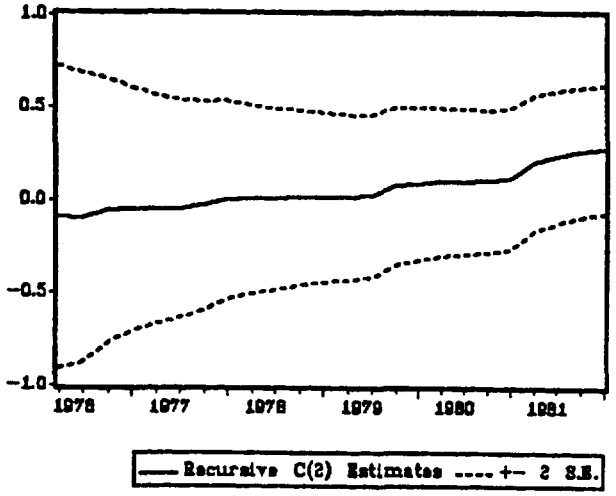
estimate of the inertia coefficient from approximately 0.55 in 1977 to approximately 0.75 by late 1981. In fact, χ^2 tests on the stability of the regression reject the hypothesis that there was a break either around the first quarter of 1978 or around the third quarter of 1979 -- see table 3. The model developed above suggests two possible, and complementary explanations for these results: first, the existence of backward looking wage indexation helped maintain the degree of inflationary persistence and, second, these results provide some indication that the exchange-rate anchor program in Chile lacked credibility.

The recursive coefficient estimates for Mexico are very different from those for Chile. First, in the period preceding the adoption of the *Pacto* there is a steady increase in the degree of inflationary inertia. The point estimate of the coefficient of lagged CPI inflation increases from 0.5 in 1984 to a peak of 0.95 in the first quarter of 1988. This suggests that after the peso crisis of 1982, inertia became increasingly ingrained, and in late 1987 the Mexican economy came close to losing its anchor. In early 1988, however, when the *Pacto* was revised and the nominal exchange rate was pegged, there was a clear and significant decline in the degree of inertia. As the χ^2 statistics in table 3 show, the hypothesis of a structural break in the inflationary equation cannot be rejected at conventional levels. The recursive point estimate of the coefficient of lagged inflation declines steadily, until it reaches 0.55 in the second quarter of 1989. Interestingly enough, however, from that point onward, instead of further declining, the estimated degree of inertial inflation begins to increase slowly, reaching 0.8 by the end of 1994. Although this level is still significantly lower than the peak inertial level achieved in late 1987, it is still substantial. What is more important, however, is that these increases in the estimated degree of inertia suggest that as the Mexican program progressed through time its degree of credibility tended to decline rather than increase as the architects of the plan had expected. A likely explanation for this is that as time passed and the peso became more and more appreciated in real terms, the public sensed that it was more likely that the authorities would abandon the program, reverting to a more flexible type of system.

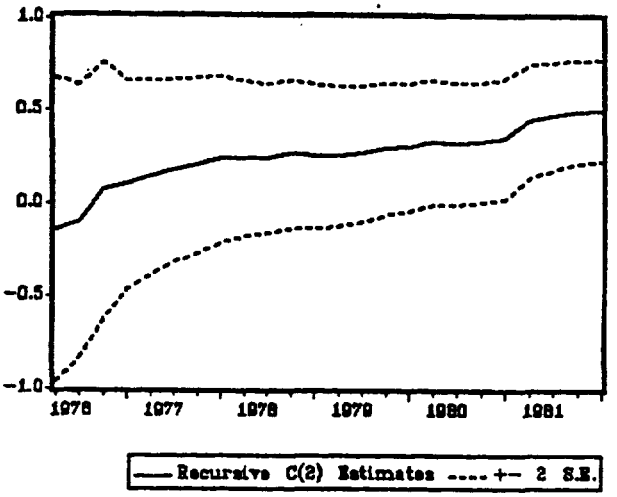
Figures 5 and 6 contain results from the recursive coefficients estimation of lagged inflation of sectoral components of the Chilean and Mexican CPI indexes. As can be seen, overall, these figures tell a very similar story than that of the aggregate indexes. Although the

Figure 5. Chile: Sectoral Recursive Coefficient Estimates

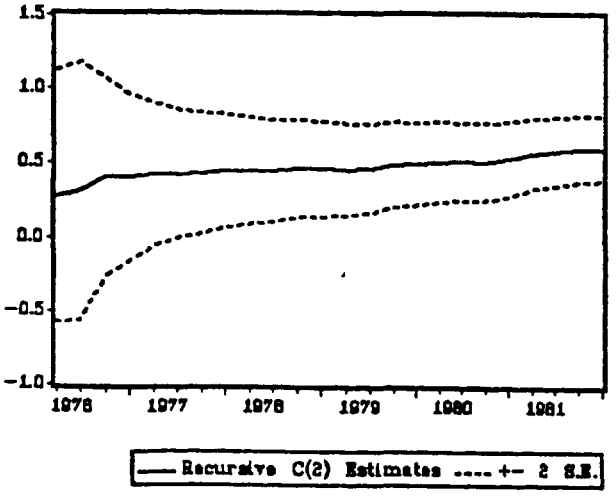
A. Clothing



B. Food



C. Housing



D. Other

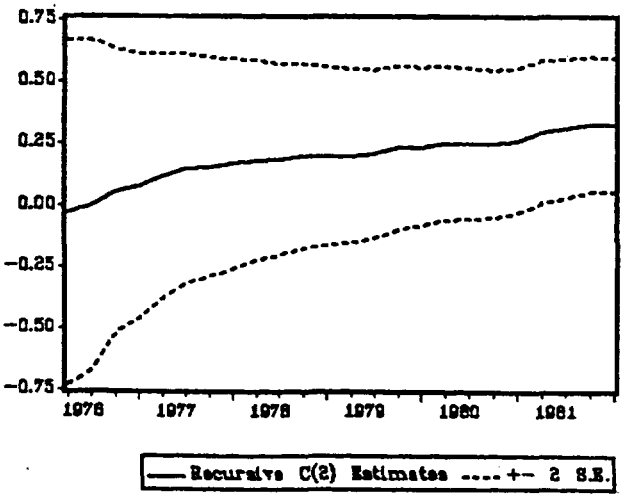
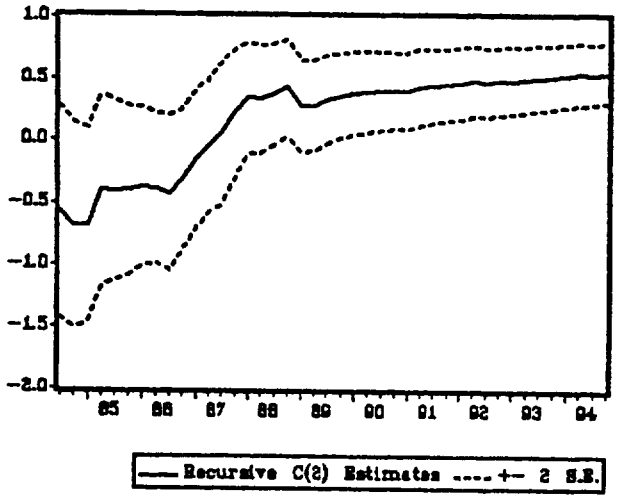
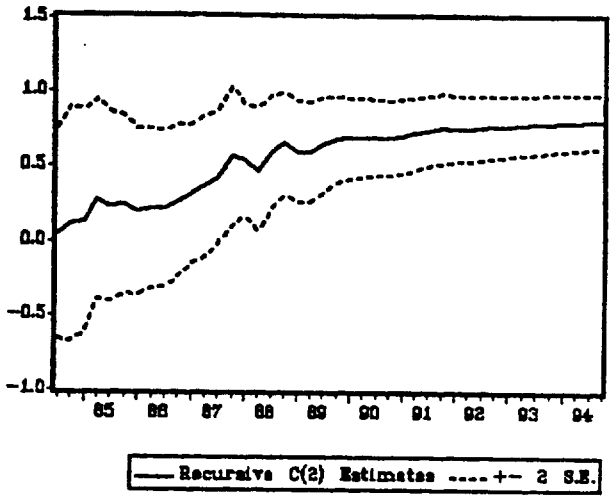


Figure 6. Mexico: Sectoral Recursive Coefficient Estimates

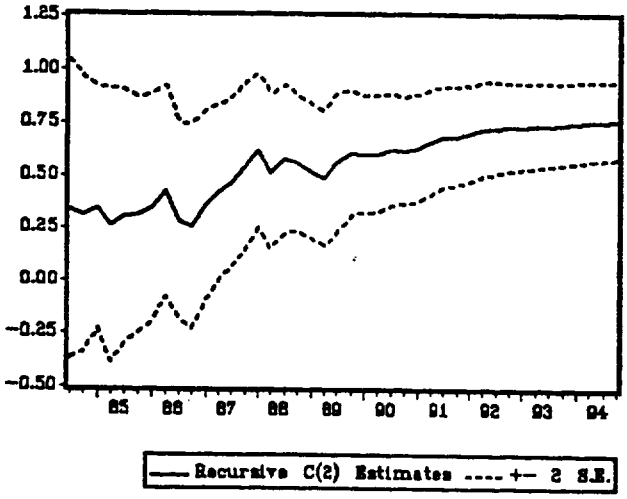
A. Education



B. Clothing



C. Food



D. Furniture

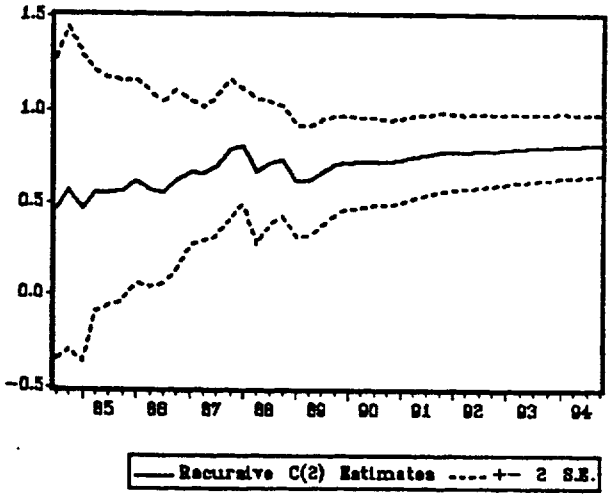
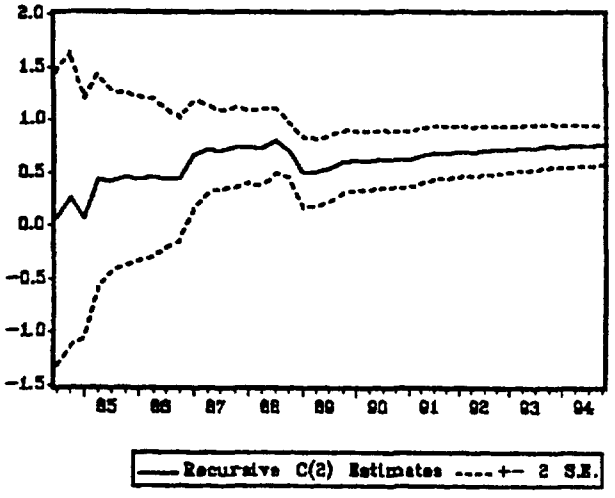
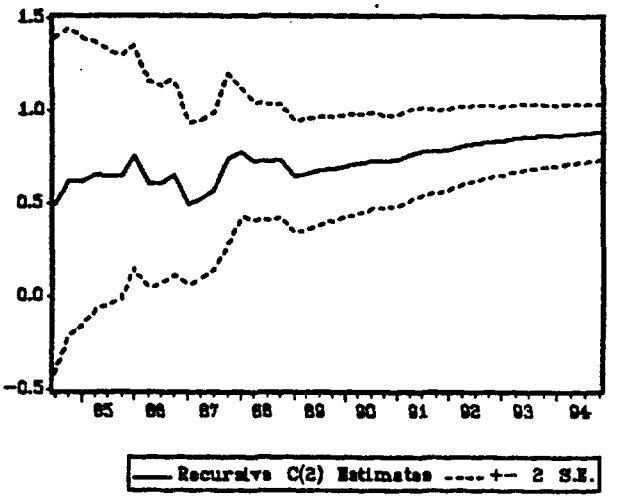


Figure 6. Mexico: Sectoral Recursive Coefficient Estimates
(continued)

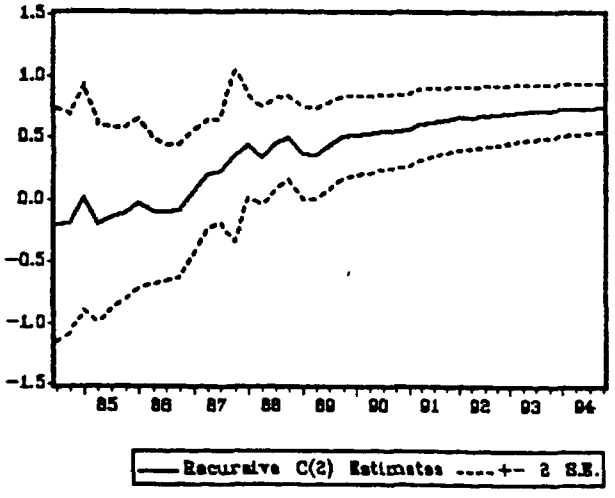
E. Health Services



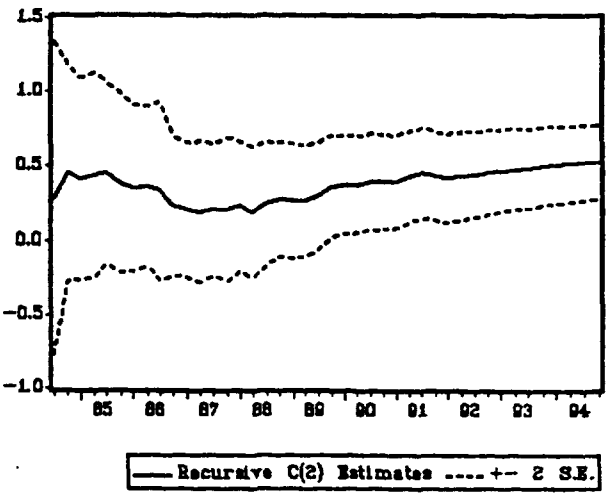
F. Housing



G. Other Services



H. Transport



levels of the point estimates tend to vary across sectors, their time trends are consistent: while in Chile no break in behavior is observed, in Mexico there generally is a decline in inertia in 1988, followed by a steady increase after 1989.

To sum up, then, the results reported in this section suggest that the adoption of the nominal exchange-rate anchor policy in Chile did not affect in any way the degree of inflationary inertia in that country. This is likely to have been the consequence of two factors: the imposition of backward looking wage indexation since 1976, and of a low degree of credibility in the switch of exchange rate policy. In Mexico, on the other hand, the adoption of the nominal exchange rate policy within the framework of the *Pacto*'s income policies did reduce significantly the degree of inflationary persistence. The statistical analysis of Mexico's inflation shows a marked structural break in the first quarter of 1988. However, the Mexican stabilization program succeeded in generating only a temporary reduction in inertia. As time progressed, the program seemed to have lost credibility, with the consequent increase in inertia.

III.3 Model-Free Measures of Persistence

The results reported above have been based on the estimation of the model developed in section II and, thus, are constrained by the theoretical structure imposed by it. In this subsection I investigate further the effects of the Chilean and Mexican stabilization programs by analyzing persistence from a model-free perspective.[13] Table 4 contains data on autocorrelations for monthly and quarterly inflation (both CPI and PPI), and for several subperiods in both countries. The time periods have been selected in order to include the period preceding the stabilization program, as well as several subperiods following its implementation. Figure 7, on the other hand, contains estimates of Cochrane's (1988) variance ratio indicator of persistence. This ratio measures how important is the random walk component of a particular time series, and is defined in the following way:

$$V(k) = (1/k)\ \{[\text{var}\ (\pi_t - \pi_{t-k})]/[\text{var}\ (\pi_t - \pi_{t-1})]\}.$$

[13] Obstfeld (1995) has recently argued that changes in the degree of inflationary persistence across exchange-rate regimes should be based on model-free techniques.

Table 4.

A. Chile: Inflation Persistence during Selected Periods

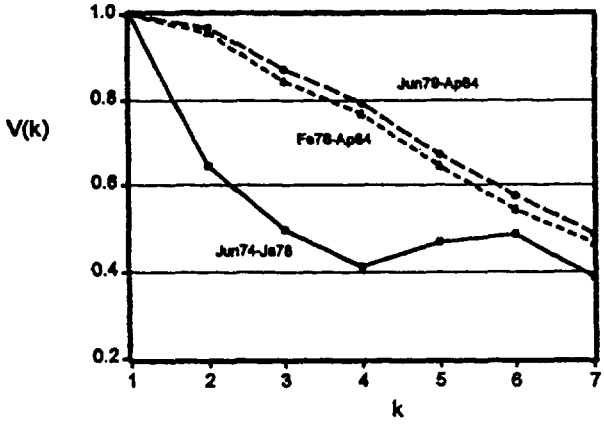
		Inflation autocorrelations by periods lagged					
Indicator	Period	1	2	3	4	5	6
CPI	1974.06-1978.01	0.709	0.574	0.513	0.447	0.336	0.248
	1978.06-1982.04	0.775	0.616	0.490	0.473	0.407	0.348
	1979.06-1982.04	0.789	0.613	0.455	0.412	0.354	0.309
	1974.1-1978.1	0713	0.486	0.415	0.387	0.168	-0.111
	1978.2-1982.1	0.694	0.407	0.234	0.128	-0.003	-0.159
	1979.2-1982.1	0.708	0.426	0.213	0.035	-0.123	-0.234
PPI	1974.06-1978.01	0.649	0.557	0.528	0.452	0.392	0.325
	1978.06-1982.04	0.760	0.599	0.434	0.333	0.315	0.289
	1979.06-1982.04	0.749	0.521	0.283	0.160	0.144	0.213
	1974.1-1978.1	0.679	0.552	0.430	0.373	0.241	-0.052
	1978.2-1982.1	0.606	0.264	0.244	0.250	0.106	-0.191
	1979.2-1982.1	0.602	0.221	0.178	0.120	-0.045	-0.227

B. Mexico: Inflation Persistence during Selected Periods

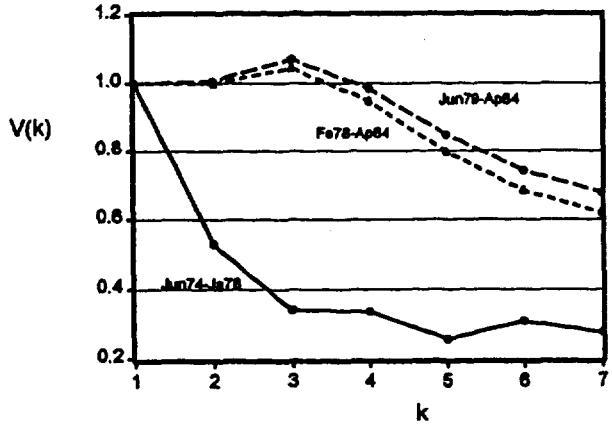
		Inflation autocorrelations by periods lagged					
Indicator	Period	1	2	3	4	5	6
CPI	1980.01-1987.12	0.659	0.556	0.513	0.553	0.468	0.390
	1988.01-1994.12	0.544	0.293	0.150	0.084	0.075	0.039
	1989.01-1994.12	0.744	0.465	0.336	0.265	0.276	0.258
	1980.2-1987.4	0.751	0.555	0.361	0.239	0.002	-0.141
	1988.1-1994.4	0.239	0.031	0.017	0.086	-0.002	-0.028
	1989.1-1994.4	0.534	0.307	0.432	0.615	0.186	-0.022
PPI	1980.01-1987.12	0.440	0.313	0.341	0.395	0.378	0.269
	1988.01-1994.12	0.290	0.087	0.120	0.080	0.041	0.034
	1989.01-1994.12	0.643	0.422	0.361	0.364	0.344	0.327
	1980.2-1987.4	0.706	0.496	0.365	0.249	0.022	-0.175
	1988.1-1994.4	0.151	0.024	-0.021	0.073	-0.016	-0.044
	1989.1-1994.4	0.648	0.406	0.370	0.477	0.179	0.044

Figure 7. Cochrane Variance Ratios

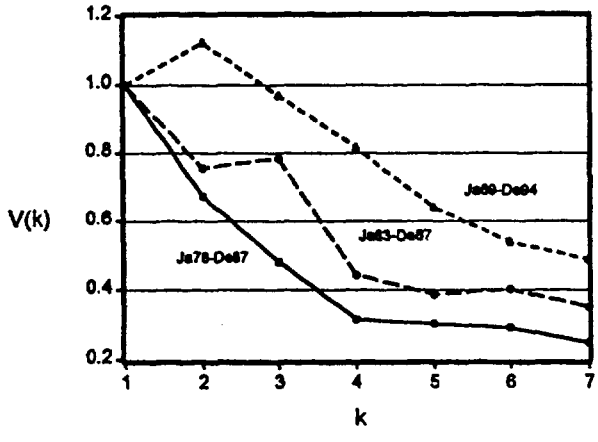
A. Chile: CPI Inflation, Cochrane Variance Ratio (adjusted)



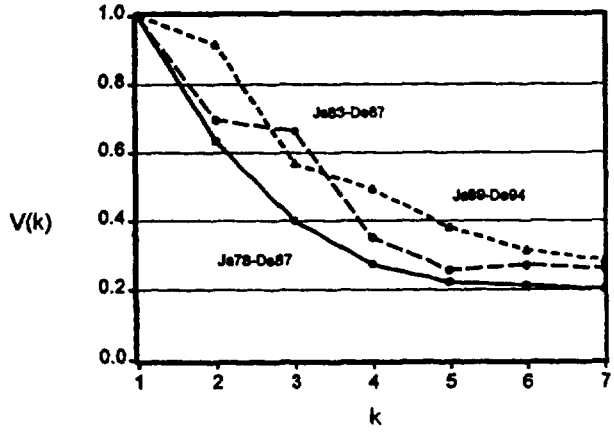
B. Chile: PPI Inflation, Cochrane Variance Ratio (adjusted)



C. Mexico: CPI Inflation, Cochrane Variance Ratio (adjusted)



D. Mexico: PPI Inflation, Cochrane Variance Ratio (adjusted)



The higher (lower) the value of V(k), for large ks, the more (less) important is the permanent component of changes in π. In other words a value of V(k) close to 1 reflects a significant degree of persistence; a low value of V(k) -- say a value close to zero -- will capture an absence of inertia.[14]

The data on autocorrelations for Chilean CPI inflation in table 4 confirms the results discussed in the previous section: there is no evidence of a decline in persistence after the anchor program was adopted in 1978, nor after it was strengthen in 1979. Interestingly enough, however, the autocorrelations on PPI inflation suggest that after June 1979, producer prices inflationary inertia tended to decline somewhat -- autocorrelations for lags greater than 2 are significantly lower after June of 1979. This difference in persistence across price indexes reflects the fact that the CPI has a very high component of nontradables, which are particularly susceptible to wage rate indexation of the type in effect in Chile after 1976.

The autocorrelation coefficients for Mexico are particularly interesting, since at first sight appear to contradict the results obtained from the recursive coefficients estimates reported above. In fact, these estimates suggest that after the adoption of the *Pacto* in late 1987 there was an important decline in the degree of inertia -- for example, the monthly autocorrelation coefficients for the 1988.01-1994.12 period are much lower than those for the 1980.01-1987.12 period. This very substantial decline in persistence is, however, largely the result of 1988 when the exchange rate and many prices were actually fixed. As can be seen from the table, when 1988 is excluded from the sample, and the period 1989-1994 is considered, the decline in persistence is much smaller. This is in fact consistent with the recursive coefficient results that suggested a sharp drop in inertia immediately following the adoption of the program, followed by a steady increase in it.

The estimated variance ratios V(k) in figure 7 are, generally speaking, consistent with the previous findings for Chile.[15] There is no strong evidence that in Chile the adoption of the

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[14] See Cochrane (1988) for details.

[15] Since we are using small samples and standard errors were not calculated, these ratios should be interpreted with caution. However, the ratios have been adjusted for their respective

exchange-rate anchor program reduced inflationary persistence. The results for Mexico suggest that there was no discernible decline in the permanent component of inflation series after the program was the exchange-rate-based stabilization program was adopted.[16]

IV. Some Concluding Thoughts (Incomplete)

Exchange-rate-based stabilization programs have usually been adopted as a way of rapidly reducing inflationary inertia and stabilizing prices. Many policy makers have indeed argued that the success of this type of program will depend on the ability to reduce inflation persistence (Aspe 1993). In this paper I have argued that the adoption of an exchange-rate-based stabilization program can be analyzed in a rational, policy-making framework where, at some point, there is a change in the economic authorities' preferences. A government that had historically placed a rather low weight on price stability -- and a high one on the accomplishment of some real objective -- suddenly announces that reducing inflation has become its overriding objective. In this setting the success of the program will largely depend on how credible is the government's announcement of a change in preferences. In a Barro-Gordon setting I show that a fully credible exchange-rate-based stabilization program will eliminate inertia immediately; however, if the announced change in policy has a low degree of credibility, inertia will only decline slowly. Moreover, if a high percentage of wages are subject to staggered -- or worse yet, backward looking -- contracts, inertia will decline slowly after the adoption of the program.

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degrees of freedom. See Cochrane (1988, p. 907).

[16] In order to avoid the effect of 1988, the post-stabilization-program period was started in 1989.01. However, if the longer 1988.01-1994.12 period is considered there is still no evidence of a decline in persistence.

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Appendix (Incomplete)

Data Sources

Variable	Chile	Mexico
CPI, quarterly and monthly	IMF, International Financial Statistics (IFS)	IFS
PPI, quarterly and monthly	IFS	IFS
Sectoral CPIs, quarterly	Banco de Chile, Boletín Mensual, various issues.	Banco de México.
U.S. PPI, quarterly and monthly	IFS	IFS
M1, quarterly	Banco de Chile, Boletín Mensual, various issues.	IFS
Domestic Credit, quarterly	Banco de Chile, Boletín Mensual, various issues.	IFS
IIP (Index of industrial production)	Banco de Chile, Boletín Mensual, various issues.	IFS