

**Banco de México**  
**Documentos de Investigación**

**Banco de México**  
**Working Papers**

**N° 2005-01**

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July 2005

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# Reducing Inflation Through Inflation Targeting: The Mexican Experience<sup>1</sup>

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## Abstract

The paper reviews the role of monetary policy in the disinflation process that has taken place in the Mexican economy in recent years. The purpose is to show that, once an economy establishes a sustainable fiscal position, an inflation targeting framework can be seen as an efficient mechanism to impose discipline on monetary policy and, thus, to reduce inflation. This paper describes the measures that were taken after the 1995 crisis to stabilize the economy and that prevented the possibility of a fiscal dominance situation from arising. Consequently, the role of monetary policy in reducing inflation is analyzed, in particular its response to different inflationary shocks. Results show that in conducting the successful disinflationary process, Banco de México's responses to inflationary shocks have been consistent with inflation targeting principles.

**Keywords:** inflation targeting, inflation reduction, monetary policy.

**JEL Classification:** E52, E58 and F33

## Resumen

En este trabajo se describe la política monetaria en México durante el proceso de reducción de inflación que ha tenido lugar durante los últimos años. El propósito es mostrar que una vez que en una economía se alcanza una posición fiscal sostenible, el esquema de objetivos de inflación puede ser utilizado como un mecanismo eficiente para imponer disciplina en la política monetaria y de esta forma reducir la inflación de manera sostenible. En este trabajo se describen las medidas adoptadas después de la crisis de 1995 para evitar una situación de dominancia fiscal. Una vez hecho esto, se analiza el papel de la política monetaria en el proceso de reducción de la inflación, en particular su respuesta a las presiones inflacionarias. Los resultados muestran que las acciones tomadas por el Banco de México durante el proceso de reducción de la inflación fueron congruentes con las de un banco central que persigue la estabilidad de precios como su objetivo de largo plazo, es decir, con los principios que rigen un esquema de objetivos de inflación.

**Palabras Clave:** objetivos de inflación, reducción de inflación, política monetaria.

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<sup>1</sup>This paper will be published in a Kiel Institute for World Economics' Conference Volume on *Monetary Policy and Macroeconomic Stabilization in Latin America*. The authors thank Daniel Chiquiar, Alejandro Díaz de León, Rodrigo García, Daniel Sámano, Julio Santaella, Paulo Springer de Freitas, Juan Pedro Treviño and an anonymous referee for their comments. Julieta Alemán, Lorenza de Icaza, Santiago Gómez and Jéssica Roldán provided excellent research assistance..

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## 1. Introduction

This paper reviews the role of monetary policy in the disinflation process that has taken place in the Mexican economy in recent years. The purpose is to show that once an economy establishes a sustainable fiscal position, an inflation targeting framework can be seen as an efficient mechanism to impose discipline on monetary policy and, thus, to reduce inflation in a sustainable way. This paper describes the measures that were taken after the 1995 crisis to stabilize the economy and that prevented a fiscal dominance situation from arising. Then, the analysis evaluates whether the response of monetary policy to different inflationary shocks was consistent with inflation targeting principles. A brief description of the episodes of monetary tightening precedes an analysis that uses a structural VAR approach to characterize the associated inflationary shocks as either supply or demand driven. Afterwards, monetary policy rules are used to formally test the consistency between monetary policy and the inflation targeting principles.

In recent years, several economies have moved toward flexible exchange rate regimes. This trend has been accompanied by a set of guidelines or recommendations to monetary authorities known as inflation targeting principles. For monetary policy to effectively perform the role of nominal anchor of an economy, inflation targeting stresses the importance of two elements: the appropriate response of monetary policy to inflationary shocks, and transparency in its implementation. This paper shows that in conducting the successful disinflationary process that took place once a sounder fiscal position had been ensured after the 1995 crisis, Banco de México's responses to different inflationary shocks were consistent with inflation targeting principles.

The Mexican experience is interesting because it represents an emerging market economy that was able to reduce inflation from close to 52 percent in 1995, to just under 4 percent by 2003 under a flexible exchange rate regime. Furthermore, since the evidence presented shows that monetary policy has been conducted in accordance with inflation targeting principles, Mexico's experience suggests that, given a situation of no fiscal dominance, inflation targeting frameworks in emerging market economies can be useful to impose discipline on monetary policy and, thus, to ensure that it performs the role of nominal anchor of the economy.

The rest of the paper is organized as follows. Section 2 discusses the measures adopted after the 1995 crisis in order to stabilize the economy and to attain a fiscal position that would contribute to restoring credibility in the financial system and in monetary policy. Section 3 describes the evolution of monetary policy toward an inflation targeting framework and identifies three episodes of monetary policy tightening during the disinflation process. Section 4 describes and characterizes the inflationary shocks that took place during the same period. Then, in section 5, results from sections 3 and 4 are used to discuss the consistency of monetary policy decisions with inflation targeting principles. Finally, section 6 concludes.

## 2. Stabilization of the Economy

By the end of 1994, Mexico was forced to float the currency and abandon a target zone for the exchange rate. Since the Mexican economy experienced an important financial crisis throughout 1995, the situation was precarious. Under the new flexible exchange rate regime, Banco de México faced the challenge of providing the economy with a nominal anchor. As expected during a crisis, the credibility of Mexican financial and monetary institutions was not at its best. Not only did the Central Bank's policy have to become the nominal anchor of the economy, but it had to do so at a time when there was widespread uncertainty about the Bank's commitment and ability to achieve financial and price stability.

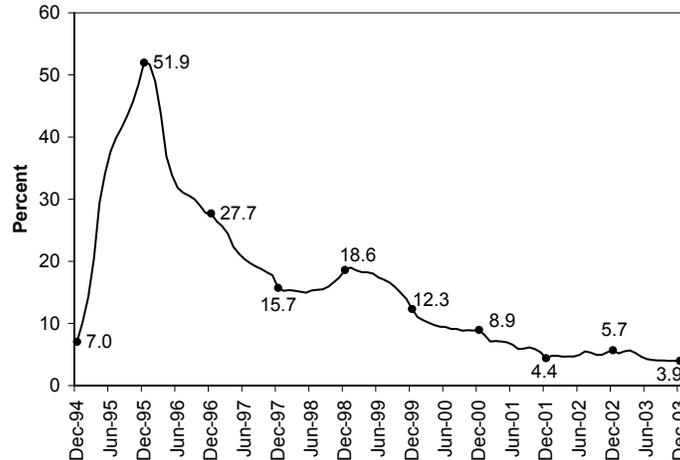
There are various papers that analyze the origins and aftermath of the crisis (Carstens and Werner 1999; Gil-Díaz 1998; Calvo and Mendoza 1996). Briefly, the build-up to the crisis was related to the following issues: (1) a rigid exchange rate regime leading to large short-term speculative capital flows and considerable relative price distortions; (2) weak banking regulation and supervision, which led to an inefficient intermediation of the large capital inflows in the years preceding the crisis; (3) an overspending economy with a large current account deficit; (4) as a result of worsening macroeconomic conditions, the government was forced to gradually concentrate its debt on short-term dollar-denominated instruments (i.e., borrowing to defend). All of the above issues interacted with each other, leading to gradually increasing disequilibria in the economy and, eventually, to a run against the currency. As the crisis unfolded, the authorities faced three central challenges for economic policy: to meet all maturing government debt obligations; to conduct an orderly macroeconomic adjustment to the reversal of capital inflows; and, to maintain the solvency and viability of the banking system. As a result, a comprehensive macroeconomic stabilization program was implemented.

First, given the magnitude of the problem that meant meeting the government's short-term dollar denominated obligations, its solution clearly laid outside the scope of any realistic macroeconomic policy adjustment. Thus, the government negotiated a financial support package of over 50 billion dollars with international financial institutions.

Second, to induce an orderly macroeconomic adjustment, consistent with the drying up of capital inflows, the challenge was to induce an orderly contraction of domestic aggregate demand, for which a large real exchange rate depreciation and expenditure reducing policies were required. Once the exchange rate depreciated, fiscal and monetary policies focused on containing the inflationary pressures induced by the initial devaluation. Fiscal policy in particular was oriented towards increasing public savings through a rise in the value added tax rate, increases in public prices, and a contraction of public expenditures. Simultaneously, monetary policy was geared towards restoring orderly financial markets and to reduce exchange rate volatility. For that purpose, the Central Bank established a limit to the expansion of net domestic credit, thus signaling that it would not "validate" further runs on the currency, and the resulting restrictive monetary policy stance induced considerable increases in nominal and real interest rates. Despite these policies, given the magnitude of the exchange rate depreciation (approximately 120 percent from December

1994, to December 1995), annual CPI inflation rose from 7 percent in December 1994 to 51.9 percent by December 1995 ( Figure 1).

**Figure 1**  
**Annual CPI Inflation, 1994:12-2003:12**



Finally, the accumulated fragility of banks and the previous indebtedness of firms and households, combined with the damaging effects of the crisis, seriously threatened the viability of the financial system. Thus, in order to avoid a systemic run on the banks, three measures were put in place. First, to stop the run on the external liabilities of commercial banks, Banco de México established a dollar liquidity facility. Second, the exchange rate depreciation drastically augmented the peso value of the dollar denominated loan portfolio, causing the capital-asset ratios of many Mexican banks to fall. To address this situation, undercapitalized banks were required to issue subordinated debt, convertible into equity, which was purchased by the government. Third, the loan portfolios of banks were deteriorating significantly as a result of an overexpansion of credit in the previous years and because of the large increase in interest rates in the aftermath of the crisis. To cope with this, the government offered debtors discounts on interest rate payments on performing loans and also offered to acquire a fraction of banks' loan portfolios at book value if banks brought in additional resources to increase their capital.

It is important to mention that right from the beginning of the crisis, a continuous effort was made by the authorities to assess and quantify the costs associated with the financial and debtor support programs, and to explain to markets that the public finances would be able to absorb these costs. The objective was to show that a fiscal dominance situation would not arise. This, as it turns out, would give monetary policy in the following years the opportunity to concentrate its efforts on reducing inflation.

As explained above, at first monetary policy actions were directed towards restoring orderly financial markets. Later on, the Central Bank started to adopt more direct measures intended to curtail inflationary pressures in the economy. In 1996, in addition to the limit to the expansion of net domestic credit, Banco de México established a nonnegative target for net international reserves accumulation. These two measures not only reassured its

commitment not to “validate” a run against the currency, but would also allow the remonetization of the economy, albeit through its external accounts. Similarly, in 1996 the Central Bank started to publish, at the beginning of every year, a projection of monetary base mainly as a reference to guide inflation expectations, although it did not adopt a formal intermediate target on narrow monetary aggregates.

Another element of the strategy to restore credibility in monetary policy consisted of a set of pre-announced rules through which Banco de México intervened in the foreign exchange market. After the crisis, one of the challenges was to restore the stock of international reserves to build up credibility on the currency so as to strengthen the viability of the flexible exchange rate regime. The main source of international reserve accumulation came from the exports of the state oil company *Petróleos Mexicanos* (PEMEX). PEMEX’s dollars are sold directly to Banco de México at the market exchange rate. This mechanism has two benefits. First, it allows the Central Bank to accumulate international reserves without discretionary interventions. Second, it isolates the foreign exchange market from variations in the international price of oil. Later on, in 1996 the Foreign Exchange Rate Commission introduced an instrument explicitly designed to foster international reserves accumulation.<sup>2</sup> It consisted of selling put options once a month to sell dollars to the Central Bank on any working day at the “reference interbank exchange rate” (called “FIX” rate), determined on the previous working day, provided such rate did not exceed the average of the FIX rate in the 20 days prior to the exercise date.<sup>3</sup> The instrument was designed so that market participants would have the incentive to exercise the options when the exchange rate appreciated; thus, Banco de México accumulated reserves without interfering with the floating exchange rate regime. Afterwards, in 1997 a third instrument was introduced to reduce exchange rate volatility in times when the foreign exchange market experienced low levels of liquidity. This consisted of an automatic mechanism through which the Central Bank would auction 200 million dollars in the event that the exchange rate depreciated on any given day more than 2 percent with respect to the FIX exchange rate of the previous day.<sup>4</sup> This instrument added symmetry with respect to the direction in which the Central Bank could intervene in the foreign exchange market.

The strategy to accumulate international reserves, which relied on non-discretionary interventions since all three mechanisms followed previously announced rules, proved to be successful in restoring a considerable stock of international reserves in light of the expected remonetization process that the economy underwent as a result of its successful stabilization.<sup>5</sup> Furthermore, to guarantee that the accumulation of international reserves

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<sup>2</sup> The Commission consists of three members of the Ministry of Finance and three of Banco de México, with the Ministry of Finance casting the deciding vote in case of a tie.

<sup>3</sup> See Banco de México (1996) for a detailed discussion of the instrument.

<sup>4</sup> The behavior of the exchange rate in late 1995 revealed that depreciations of around 2 percent and more occurred when conditions in the foreign exchange market turned highly illiquid. Thus, the purpose of the instrument was to prevent this type of situation. See Banco de México (1997) for a detailed discussion of the instrument.

<sup>5</sup> In 2001 the Foreign Exchange Rate Commission decided to abandon the use of the dollar put option and automatic dollar auction mechanisms. Then in 2003, the Commission defined a set of rules to reduce the rate of accumulation of international reserves from PEMEX.

would not cause an overexpansion of the monetary base, Banco de México sterilized any impact on the monetary base beyond money demand growth.

One of the goals of the economic program was to stabilize the economy as orderly and as quickly as possible, so as to guarantee that a fiscal dominance situation would not arise. In doing so, the three challenges posed by the crisis were met. First, the government fulfilled all its obligations. Second, the economy adjusted swiftly to a new macroeconomic environment, whereby the current account deficit fell from 7.1 percent of GDP in 1994 to 0.61 percent in 1996 and 1.8 percent in 1997. Third, a breakdown of the financial system was avoided.

Henceforth, as the policies and programs began to yield results, economic activity resumed its growth path. After a contraction of 6.1 percent in 1995, GDP resumed growth at 5.1 percent and 6.7 percent in 1996 and 1997, respectively. A key element to this development was the declining pattern of inflation, from 51.9 percent in 1995 to 27.7 percent in 1996 and to 15.7 percent in 1997 (Figure 1), which resulted in a downward trend in nominal and real interest rates; clearly, this contributed to gradually easing the private debt overhang problem. Furthermore, as the cost of the financial and debtor support programs was incorporated into the long-term fiscal policy agenda, the possibility of fiscal dominance eventually stopped representing a threat for macroeconomic stability. All these elements were fundamental in allowing monetary policy to focus later on on actively pursuing long-run price stability.

### **3 Monetary Policy**

As the economy stabilized, Banco de México concentrated its efforts on reducing inflation. It can be said that the strategy consisted mainly of three elements: to improve transparency in the implementation of monetary policy, to maintain a clear restrictive bias in order to induce a sustainable reduction in inflation and to respond appropriately to inflationary shocks.

#### **3.1 Transition towards a Fully Fledged Inflation Targeting Framework**

Since 1995 Banco de México has defined as its main instrument to affect interest rates a target for the cumulative balance of commercial banks' current accounts at the Central Bank ("corto").<sup>6</sup> With this instrument the Central Bank is able to affect interest rates by inducing (through open market operations) an overdraft in these accounts (of one or several banks), since banks have to pay a penalty on the amount of the overdraft; this operational procedure is similar to the non-borrowed reserves target strategy followed by the U.S. Federal Reserve in the early 1980s.<sup>7</sup> Although this is an instrument referred to quantities,

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<sup>6</sup> See Banco de México (1996, 2000) for a description.

<sup>7</sup> When the Central Bank induces an overdraft in the system, to avoid paying the penalty (i.e., higher interest rates) each bank tries to avoid being the one that ends up with the overdraft, and therefore has the incentive to raise interest rates on its deposits and/or loans. Since positive balances receive no interests and the penalty for negative balances is defined as two times the market short-term interest rate, the instrument is symmetric and gives the incentive to banks to maintain zero balances.

given the relatively small magnitude of the target for the said cumulative balances, it should be interpreted more as a signaling device in terms of the direction in which the Central Bank wants interest rates to move. As it turned out, three characteristics of this instrument proved to be useful through the disinflation process. First, starting in 1998, the Bank was able to signal its continuous bias toward a restrictive monetary policy stance to reduce inflation by setting a negative target on commercial banks' current accounts (i.e., overdraft). Second, to cope with inflationary pressures related to higher frequency shocks (among these, those related to the cyclical phase of the economy), the Bank was able to follow a "lean against the wind" policy by signaling changes in interest rates through changes in the objective for the balance of commercial banks' current accounts, that meant a larger or smaller target for the overdrafts. Third, since the precise level of interest rates is determined by market participants, this instrument allows interest rates to decrease as fast as risk premiums decrease.

By 1998, announcements of changes in the instrument ("corto") began to be accompanied with a discussion of the reasons behind the decision to modify it. This strategy enhanced transparency in the implementation of monetary policy and improved the effectiveness of the instrument to signal the stance of monetary policy. Henceforth, changes in the "corto" began to be associated with changes in the stance of monetary policy, that is, with the direction the Central Bank wanted interest rates to move. Later on, transparency was further enhanced with several announcements or measures adopted by Banco de México. In 1999, the medium-term inflation objective for CPI inflation was first defined as: "... the convergence of domestic inflation towards external inflation by 2003" (Banco de México 1999:137). Then, in 2000 the Central Bank started publishing quarterly inflation reports, containing, among others, detailed discussions of the sources of inflationary pressures. In that same year, Banco de México introduced the concept of core inflation as an important element in the analysis of inflation, particularly in the evaluation of inflationary shocks.

The process towards transparency was reinforced in 2001, when Banco de México announced that it was formally adopting an inflation targeting framework. Since 1995, the limits to the expansion of net domestic credit had resulted to be nonbinding, given that the yearly targets for the nonnegative accumulation of net international reserves had been exceeded. In effect, every year the accumulation of net international reserves surpassed the expansion of the monetary base, and thus, year after year net domestic credit decreased. Therefore, in 2001 these two elements were excluded from the monetary policy program announced for that year. Then, in 2002 a long-term inflation target was defined at 3 percent for CPI inflation, with an interval of variability of +/- 1 percentage point established mainly to reflect the transitory impact on inflation of relative price adjustments. Finally, starting in 2003, monetary policy announcements have been made at preestablished dates.

As a result of the transition towards a fully fledged inflation targeting framework, the objective and implementation of monetary policy has become more transparent and open to public scrutiny. Similarly, this process has fostered the accountability of Banco de México and has helped to anchor inflation expectations.

### 3.2 Episodes of Monetary Policy Tightening

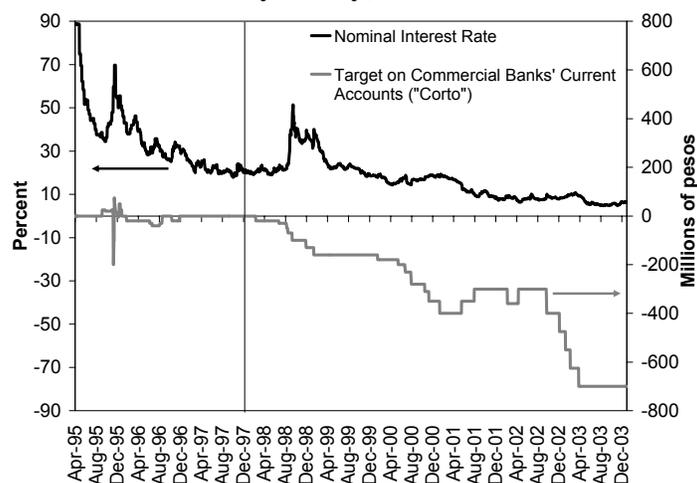
While transparency in the implementation of monetary policy is helpful to restore credibility and to anchor inflation expectations, it is certainly not enough to reduce and stabilize inflation at low levels. Clearly, an appropriate response of monetary policy to inflationary shocks is needed to consolidate the role of monetary policy as nominal anchor of the economy.

Since 1995 Banco de México's main instrument to affect interest rates has been the "corto". As explained in the previous section, this type of instrument implies that short-term interest rates are determined by the market and not directly by the Central Bank. This could suggest that in order to identify changes in the monetary policy stance, it would be enough to look for the dates when the Central Bank has announced a change in the "corto". However, since the instrument is intended only as a signal of the direction the Central Bank wants interest rates to move, these do not always react immediately after the announcement. Thus, to account for changes in the monetary policy stance, clearly short-term interest rates also have to be considered.

Figure 2 shows the short-term nominal interest rate (daily interbank interest rate) and the target for the cumulative balance of commercial banks' current accounts at the Central Bank ("corto") for the 1995-2003 period. It is important to note that during 1995 and 1996, Banco de México modified the instrument several times within very short intervals on different occasions (for example, eight times during November 1995). Since some of these changes were in one direction (restriction), and others in the opposite (relaxation), it is difficult to argue that the Bank was trying to signal changes in the stance of monetary policy. As discussed in the previous section, after the crisis it can be argued that the main concern of monetary policy was to restore order in financial markets. In this context, changes in the "corto" during 1995 and 1996 should be viewed mainly as actions intended to influence interest rates for a very short time horizon (days or weeks), so as to reestablish orderly conditions in financial markets.

By 1998, the main challenges posed by the crisis had been mostly dealt with; i.e., throughout 1995, 1996 and 1997 all government debt obligations had been met, an orderly macroeconomic adjustment took place, and financial and debtor support programs contributed to maintaining the solvency and viability of the banking system. Therefore, the possibility of a fiscal dominance situation arising had basically disappeared. This allowed Banco de México to start using monetary policy in a more pro-active and forward-looking way to combat inflation, which at the time had already declined from 51.9 percent in 1995, to 15.7 percent in 1997. Figure 2 shows that in 1998, the Bank started to signal its permanent bias toward a restrictive monetary policy stance through a permanent negative (overdraft) target on the cumulative balance of commercial banks' current accounts. Likewise, as explained in the previous section, in 1998 changes in the instrument began to be accompanied with an announcement of the reasons behind the decision to modify the stance of monetary policy. In what follows, the discussion concentrates on the 1998-2003 period.

**Figure 2**  
**Nominal Interest Rate and Changes in the Instrument**  
**of Monetary Policy, 1995:04-2003:12**



Following the type of approach in Friedman and Schwartz (1963) and Romer and Romer (1989), we combine statistical information (interest rates, inflation, exchange rate, “corto”, etc.) among other things, with anecdotal evidence included in official statements that accompanied the announcements of monetary policy in order to identify episodes in which monetary authorities restricted the stance of monetary policy.

Three episodes of monetary policy tightening are thus identified. Figures 3.1 and 3.2 show nominal (weekly average of daily interbank interest rate) and ex-ante real interest rates (computed using the weekly average of the 28-day treasury bill interest rate and the twelve months ahead inflation expectations reported in the weekly Infosel survey), with vertical lines representing changes in the “corto”.<sup>8</sup> The three shaded areas correspond to the episodes in which, it is argued, monetary policy was tightened. All three episodes have some characteristics in common. First, within each episode, the instrument of monetary policy (“corto”) was increased on several occasions, signaling a more restrictive stance.<sup>9</sup> Second, both nominal and real interest rates present an upward trend during these three episodes. Third, monetary policy announcements on the dates the instrument was modified describe specific shocks that Banco de México considered posed risks to the disinflation process.<sup>10</sup>

During the first episode (1998:03-1999:01), inflationary pressures arose from an increase in the country’s risk perception and from an exchange rate depreciation due to contagion from financial crises in other emerging market economies (East Asian economies in 1997, Russia in 1998, and Brazil in early 1999). Throughout the second episode (2000:01-2001:01),

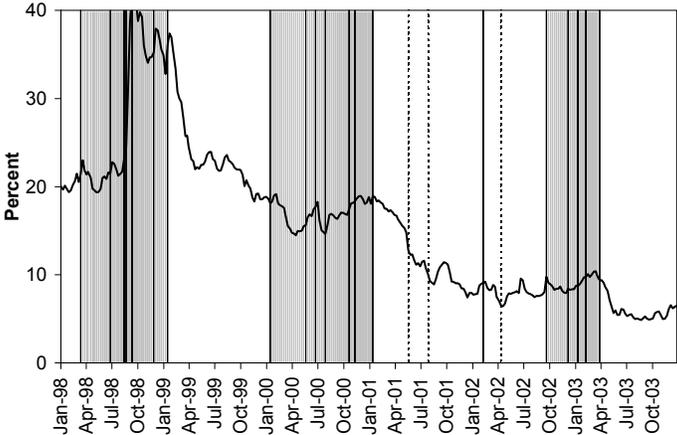
<sup>8</sup> Infosel is a private firm that reports financial information online and also conducts a weekly survey on inflation expectations among market participants.

<sup>9</sup> The increase in the instrument on February 2002 is not considered as part of the third episode of monetary policy restriction because on April 2002 Banco de México announced a change in the “corto” in the opposite direction.

<sup>10</sup> See Banco de México (2003).

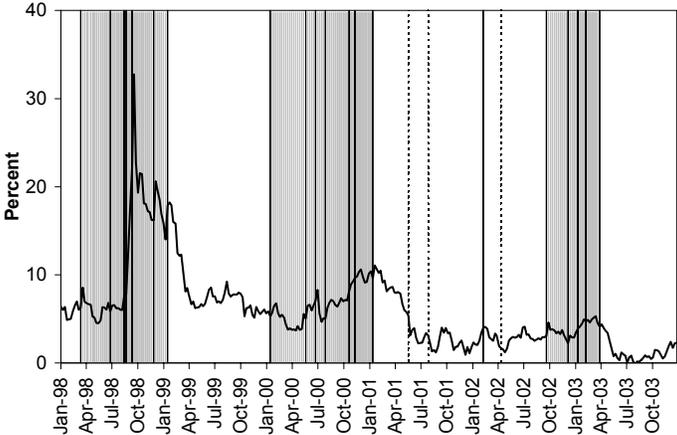
inflationary pressures arose mainly from a rapid expansion of aggregate demand, coming both from U.S. demand for Mexican exports and, possibly, from the cyclical increase in expenditures that typically takes place in the months preceding a federal election. Finally, during the third episode (2002:09-2003:03), the driving force behind inflationary pressures was a step hike in public prices, in particular in residential electricity tariffs. These inflationary shocks are discussed in the following section.

**Figure 3.1**  
**Nominal Interest Rate and Changes in the Instrument of Monetary Policy\*, 1998:1-2003:12**



\* Solid lines represent the dates when the instrument changed toward restriction and dotted lines represent changes toward relaxation.

**Figure 3.2**  
**Ex-Ante Real Interest Rate and Changes in the Instrument of Monetary Policy\*, 1998:1-2003:12**



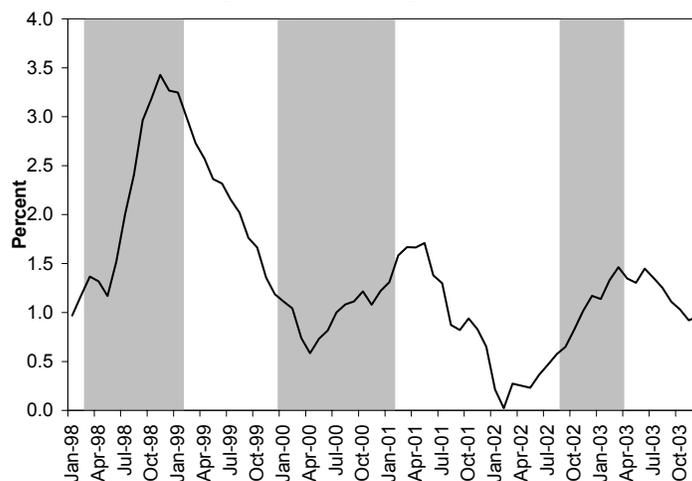
\* Solid lines represent the dates when the instrument changed toward restriction and dotted lines represent changes toward relaxation.

#### 4. Inflationary Shocks

One of the main purposes of identifying the sources of inflation is to determine whether inflationary pressures come from the supply side in the form of cost-push shocks or whether they are derived from demand shocks. As will be explained in the following section, this distinction is important, since, as is well known, according to the inflation targeting principles the appropriate monetary policy response could be different in each case.

A casual inspection of Figures 4.1 and 4.2, in which the inflation expectations gap and the output gap are shown, is helpful to start analyzing the nature of the inflationary shocks during the aforementioned episodes.<sup>11</sup> The first and third episodes are characterized by an upward trend in the inflation expectations gap and a downward trend in the output gap. This suggests that cost-push (supply) shocks are likely to have been the main source of inflationary pressures. On the other hand, during the second episode, both the inflation expectations gap and the output gap presented (for the most part) an upward trend, suggesting that inflationary pressures could have been demand driven.

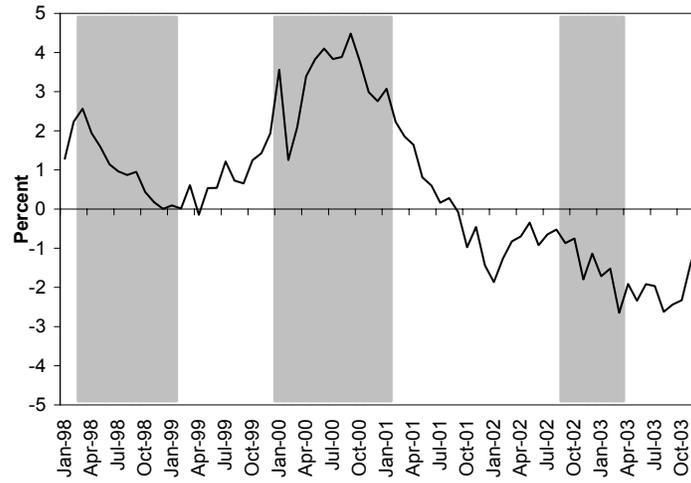
**Figure 4.1**  
**Inflation Expectations Gap\*, 1998:1-2003:12**



\* Shaded areas correspond to episodes of monetary policy restriction.

<sup>11</sup> The inflation expectations gap is defined as the difference between the monthly average of twelve months ahead expected annual inflation and the twelve months ahead annual inflation target. Inflation expectations are obtained from the Infosel survey, although results are similar if inflation expectations are obtained from the Banco de México survey. The target is computed through a linear interpolation of the end-of-year annual inflation targets announced by Banco de México. The output gap is computed using a monthly index of economic activity (IGAE) and a trend defined as the average between linear and Hodrick-Prescott filter trends.

**Figure 4.2**  
**Output Gap\*, 1998:1-2003:12**



\* Shaded areas correspond to episodes of monetary policy restriction.

To formally discuss the origin of these inflationary shocks, a structural VAR methodology on monthly data is used. The two variables included in the VAR are output,  $y_t$ , based on IGAE, and prices,  $p_t$ , based on the CPI. Table 1 presents the results of Dickey-Fuller and Phillips-Perron unit root tests, which suggest that both variables are integrated of order one.<sup>12</sup>

**Table 1**  
**Unit Root Tests: 1998:01-2003:12**

Variable	Dickey-Fuller t-statistic	Phillips-Perron t-statistic	Critical Value at 95%
$y_t^*$	-1.67	-1.76	-3.47
$p_t^*$	-2.48	-1.90	-3.47
$\Delta y_t^{**}$	-3.92	-10.24	-2.90
$\Delta p_t^*$	-4.63	-4.63	-3.47

\* Test includes constant and trend.

\*\* Test includes constant and no trend.

The long-run properties of output and prices suggest that the VAR representation can be expressed as follows:<sup>13</sup>

<sup>12</sup> Variables have been seasonally adjusted and expressed in logs.

<sup>13</sup> Results of the Johansen cointegration test (not shown) suggest that at 5 percent significance level the null hypothesis of zero cointegrating vectors is rejected and that it is not possible to reject the null hypothesis of one cointegrating vector. Therefore, the VAR is specified in levels.

$$B(L)x_t = v_t, \quad (1)$$

where  $B(L)$  is the matrix on the lag operator,  $x_t = [y_t, p_t]$  and  $v_t$  is a vector with the reduced-form innovations of the VAR:  $[v_t^1, v_t^2]$ .

$E(L)$  is then defined as  $B(L)^{-1}$ , and the moving average representation of the VAR is given by

$$x_t = E(L)v_t, \quad (2)$$

where the variance-covariance matrix of reduced-form innovations is given by

$$\Sigma = v_t v_t'. \quad (3)$$

The reduced-form innovations,  $v_t$ , are defined as linear combinations of the structural shocks,  $\varepsilon_t^1$  and  $\varepsilon_t^2$  ( $v_t' = [\varepsilon_t^1, \varepsilon_t^2]$ ):

$$v_t = S\varepsilon_t, \quad (4)$$

where  $S$  is a two-by-two invertible matrix. Then,  $C(L)$  is defined as  $E(L)S$ , and the structural moving average representation of the VAR is given by

$$x_t = C(L)\varepsilon_t. \quad (5)$$

To identify the structural shocks  $\varepsilon_t^1$  and  $\varepsilon_t^2$ , the matrix  $S$  has to be identified. Since the matrix  $S$  consists of four elements, four restrictions are needed. The standard approach in the literature is to assume that the structural shocks are orthogonal:

$$\varepsilon_t \varepsilon_t' = I. \quad (6)$$

Since the variance-covariance matrix  $\Sigma$  is symmetric, three of the four needed restrictions are obtained from the combination of (6), (4) and (3):

$$\Sigma = SS'. \quad (7)$$

The fourth restriction can be obtained either by directly making an assumption on one of the elements of matrix  $S$ , or by imposing another restriction on the elements of matrix  $S$ . A standard assumption in the literature is to assume that element  $S_{12}$  is equal to zero (recursive identification).<sup>14</sup> However, in the present application it is important to let the structural shocks,  $\varepsilon_t^1$  and  $\varepsilon_t^2$ , have contemporaneous effects on output and prices (no zeros on matrix  $S$ ), since the purpose of the exercise is precisely to identify the immediate response of these two variables to the structural innovations. Therefore, the fourth restriction is obtained from the assumption that, in the long-run, the structural shock  $\varepsilon_t^2$  has

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<sup>14</sup> This is the well known Cholesky decomposition.

no effect on output, that is, the fourth restriction implies that element  $C_{12}(1)$  of matrix  $C(1)$  is equal to zero (Blanchard and Quah 1989 and Clarida and Galí 1994).

It is important to mention that, in general, this identification strategy has been used over long samples to analyze the contribution of supply shocks, in the form of technology innovations, and cyclical demand shocks, to output and prices. In that case, the structural shock with the restriction of having no long-run effects on output usually has the characteristics of a demand shock. The key element is that long samples allow for the identification of low-frequency technology shocks. Therefore, demand shocks, which usually have a higher frequency than technology shocks, are identified through the structural shock on which the long-run restriction is imposed.

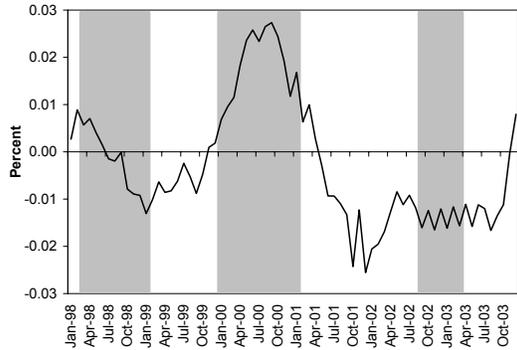
For the purpose of the exercise presented in this paper, technology shocks are of no particular interest, since in general they do not cause inflationary pressures. In our analysis, the relevant type of supply shock is of the cost-push form, since they usually have a once-and-for-all effect on prices and a temporary effect on output. This presents an important implication concerning the identification of the structural shocks. In this case, it is possible that demand shocks are not identified with the structural shock on which the long-run restriction is imposed for two reasons. The first reason is that, since the sample used in the exercise is relatively short (1998:01-2003:12), the effects of demand innovations on output could be seen as lasting for relatively long periods, with respect to the size of the sample. Alternatively, it is possible for cost-push shocks to be of a higher frequency than demand shocks. Thus, when only these two types of shocks are considered, the one with longer effects on output could be the demand shock.

The VAR is estimated with three lags.<sup>15</sup> To characterize the inflationary shocks experienced by the Mexican economy over the sample period, the estimated VAR is used to identify the contribution of each type of structural shock to output and prices over the sample period. Figures 5.1 and 5.2 show the combined contribution of both structural shocks,  $\varepsilon_t^1 + \varepsilon_t^2$ , to output and prices, respectively. Then, these combined effects are decomposed into the effect that each type of shock had on output and prices. Figures 5.3 and 5.4 show the contribution of the structural shock  $\varepsilon_t^1$  to output and prices, respectively. Similarly, Figures 5.5 and 5.6 show the contribution of the structural shock  $\varepsilon_t^2$  to output and prices, respectively. Results of this exercise suggest that the contribution of the structural shock  $\varepsilon_t^1$  to output and prices goes in the same direction, as if this type of innovation has its origin in the demand. In the case of the structural shock  $\varepsilon_t^2$ , results show that the contribution to output and prices goes in opposite directions, which suggests that this type of innovations comes from the supply side.

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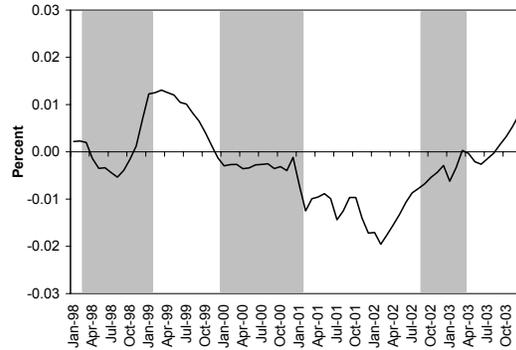
<sup>15</sup> The Akaike criteria suggest three lags. However, results are similar for specifications with different numbers of lags.

**Figure 5.1**  
**Combined Contribution of Structural Shocks  $\varepsilon_t^1$  and  $\varepsilon_t^2$  to Output\*, 1998:1-2003:12**



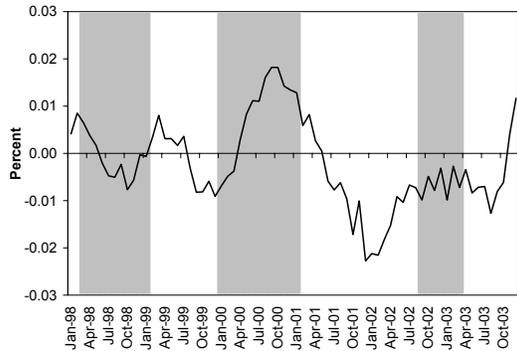
\* Shaded areas correspond to episodes of monetary policy tightening.

**Figure 5.2**  
**Combined Contribution of Structural Shocks  $\varepsilon_t^1$  and  $\varepsilon_t^2$  to Prices\*, 1998:1-2003:12**



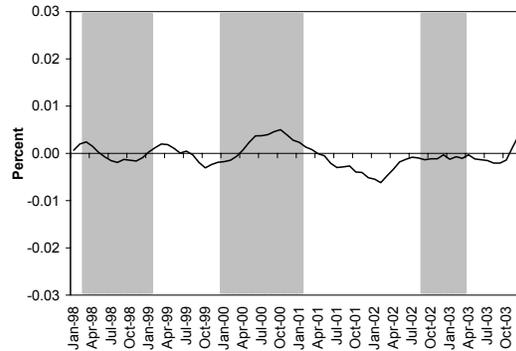
\* Shaded areas correspond to episodes of monetary policy tightening.

**Figure 5.3**  
**Contribution of Structural Shock  $\varepsilon_t^1$  to Output\*, 1998:1-2003:12**



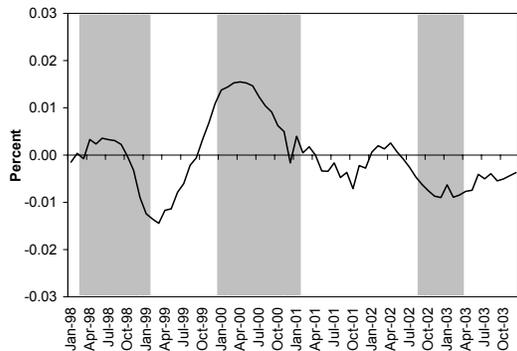
\* Shaded areas correspond to episodes of monetary policy tightening.

**Figure 5.4**  
**Contribution of Structural Shock  $\varepsilon_t^1$  to Prices\*, 1998:1-2003:12**



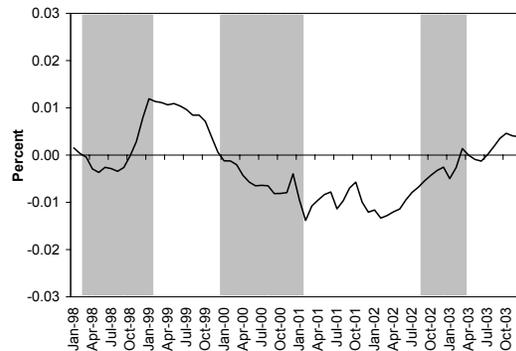
\* Shaded areas correspond to episodes of monetary policy tightening.

**Figure 5.5**  
**Contribution of Structural Shock  $\varepsilon_t^2$  to Output\*, 1998:1-2003:12**



\* Shaded areas correspond to episodes of monetary policy tightening.

**Figure 5.6**  
**Contribution of Structural Shock  $\varepsilon_t^2$  to Prices\*, 1998:1-2003:12**



\* Shaded areas correspond to episodes of monetary policy tightening.

With respect to the inflationary shock during the first episode of monetary policy tightening, Figures 5.1 to 5.6 suggest that in 1998 inflationary pressures came primarily from the supply side (structural shock  $\varepsilon_t^2$ ). Financial problems in East Asian economies, Russia, and Brazil caused volatility in the international financial markets. As a result, country risk perception for Mexico increased considerably, while the exchange rate experienced an important depreciation (Figure 6.1). Of course, this tightening of the economy's external financing constraint increased the cost of capital. Furthermore, during 1998 domestic fuel prices were increased considerably (Figure 6.2).<sup>16</sup> Thus, the evidence points to a strong adverse cost-push shock. In this case, it is interesting to note that despite the restriction on monetary policy, inflation rose from 15.7 percent to 18.6 percent during 1998 (Figure 1). However, since the restriction induced sharp increases in nominal and real interest rates (Figures 3.1 and 3.2) the adverse cost-push shock had no second-round effects of consequence on prices, and inflation resumed its downward trend in 1999.

In the case of the second episode of monetary policy tightening, Figures 5.1 to 5.6 show two shocks taking place in late 1999 and 2000. The first one is a favorable cost-push shock, with an expansion on output and a contraction on prices (structural shock  $\varepsilon_t^2$ ). This result represents the reversal of the adverse cost-push shock experienced in 1998. In this case, both country risk perception (Figure 6.1) and fuel inflation (Figure 6.2) returned to the levels they had before the 1998 events. On the other hand, Figures 5.3 and 5.4 (structural shock  $\varepsilon_t^1$ ) suggest that during 2000 the expansion of aggregate demand induced inflationary pressures. This phenomenon is explained by a rapid expansion of industrial production in the United States and, consequently, in the demand for Mexican exports (Figure 7.1); and, by an important increase in domestic expenditure (private and public consumption and investment) that took place during 1999 and 2000 (Figure 7.2). The fact that inflation presented a downward trend from 1999 to 2001 (Figure 1 in Section 2) suggests that monetary policy actions prevented inflationary pressures, originated from a possible demand shock, from having an important effect on prices.

Finally, Figures 5.1 to 5.6 suggest that inflationary pressures during 2002 and early in 2003 (third episode of monetary policy tightening) once again arose from the supply side. The contribution of the structural shock  $\varepsilon_t^2$  shows an increasing effect on prices and a decreasing effect on output. In those years the economy experienced an important shock to public prices, including electricity and gas (Figure 6.2). Clearly, this evidence points to an adverse cost-push shock which resulted in inflation rising from 4.4 percent in 2001 to 5.7 percent in 2002 (Figure 1). Again, the restriction on monetary policy induced increases in interest rates (Figures 3.1 and 3.2) and, since no second round effects of consequence occurred, inflation decreased to 3.9 percent by December 2003 (Figure 1).

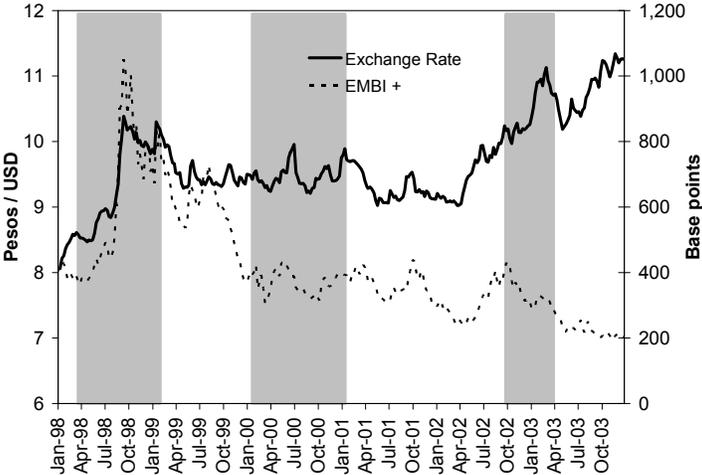
Summing up, the results suggest that inflationary pressures during the first episode in our sample in which Banco de México restricted the stance of monetary policy, came from the supply side in the form of an adverse cost-push shock. Then, during the second episode, the expansion of aggregate demand induced inflationary pressures. Finally, in the third episode in which the Central Bank restricted monetary policy, inflationary pressures came again from the supply as adverse cost-push shocks. In what follows, these results are used

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<sup>16</sup> This increase in the internal price of fuel deemed from an attempt to increase public revenues.

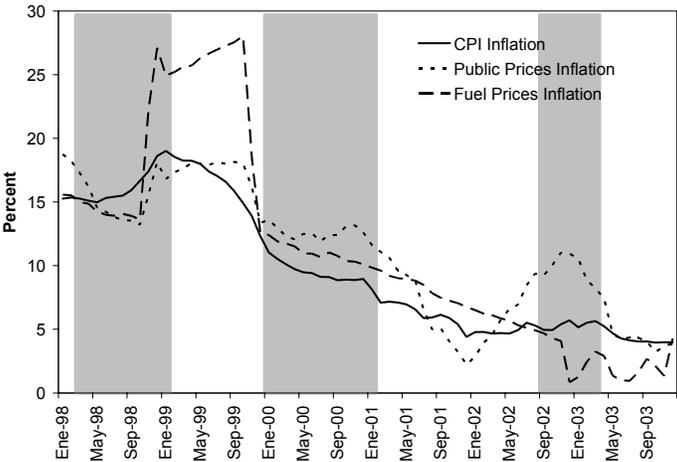
to evaluate if the tightening of monetary policy that took place during the said episodes was consistent with inflation targeting principles.

**Figure 6.1**  
**Exchange Rate and Country Risk Perception\*,**  
**1998:1-2003:12**



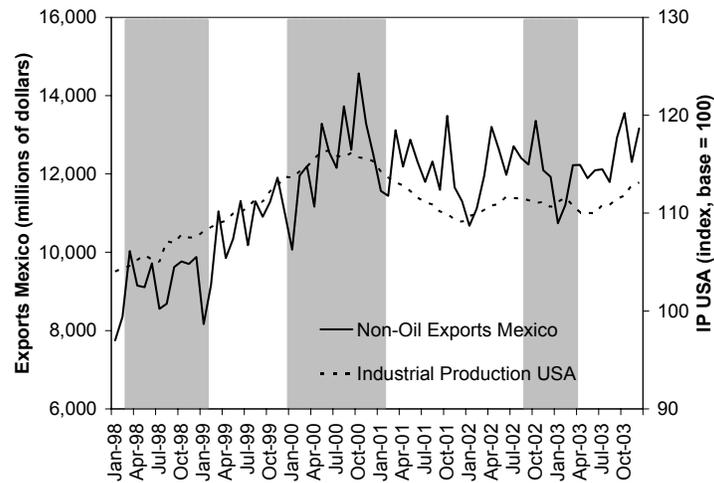
\* Shaded areas correspond to episodes of monetary policy restriction.

**Figure 6.2**  
**CPI, Public Prices and Fuel Inflation\*,**  
**1998:1-2003:12**



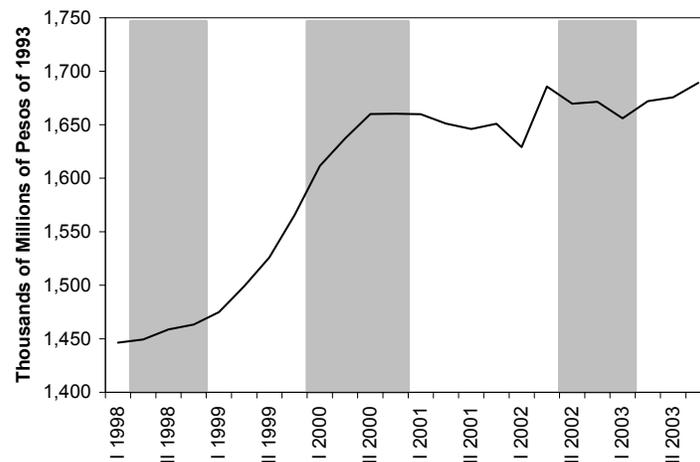
\* Shaded areas correspond to episodes of monetary policy restriction.

**Figure 7.1**  
**Industrial Production in the USA and**  
**Mexican Exports\*, 1998:1-2003:12**



\* Shaded areas correspond to episodes of monetary policy restriction.

**Figure 7.2**  
**Domestic Expenditure\*,**  
**1998:1-2003:12**



\* Shaded areas correspond to episodes of monetary policy restriction.

## 5. Inflation Targeting, Monetary Policy and Inflationary Shocks

The consensus in the inflation targeting literature (e.g., Bernanke et al. 1999, Clarida et al. 1999, Svensson 1997, 2000) is that, in the long-run, the cost of maintaining inflation low and stable is minimized when a central bank follows two general guidelines. First, when inflationary pressures have their origin in a demand shock, the recommendation is not to accommodate the effect of the shock. Second, when inflationary pressures have their origin in a cost-push (supply) shock, the recommendation is to accommodate the shock and let it

have a once-and-for-all effect on the price level and, thus, a temporary effect on inflation (first round effects). However, if the temporary effect on inflation contaminates inflation expectations, so that further variations in prices can take place (second round effects), then the recommendation is to modify the stance of monetary policy until inflation expectations get in line again with the inflation target.<sup>17</sup> The conclusion is that a central bank that systematically follows these two recommendations will significantly increase the probability of monetary policy being an effective nominal anchor. In what follows, the results from the previous two sections are used to evaluate monetary policy in light of the inflation targeting principles described above.

The first episode of monetary policy restriction (1998:03-1999:01) coincides with the adverse cost-push shock experienced in 1998. Therefore, to evaluate the consistency of monetary policy with inflation targeting principles, it is necessary to consider inflation expectations. Figure 4.1 shows that the inflation expectations gap increased. This suggests that the restriction of monetary policy during this episode was in line with inflation targeting principles. Although inflationary pressures had their origin in the supply side, inflation expectations became contaminated by the shock and represented a threat to the disinflationary process. The second episode of monetary policy restriction (2000:01-2001:01) coincides with inflationary pressures coming from a possible demand shock. As in the previous episode, the inflation expectations gap increased (Figure 4.1). Since inflationary pressures had their origin in the demand side, the restriction to the stance of monetary policy by Banco de México was consistent with inflation targeting principles. The third episode of monetary policy tightening (2002:09-2003:03) took place while the economy was experiencing a series of adverse cost-push shocks in 2002 and early 2003. In this case, the inflation expectations gap (Figure 4.1) reversed its downward trend and increased through all of 2002 and early 2003. Again, since inflation expectations became contaminated, the tightening of monetary policy was in line with inflation targeting principles.

To formalize the previous analysis, it is useful to refer to the literature on monetary policy rules (Taylor 1993, Clarida et al. 1999). The consistency of monetary policy with inflation targeting principles can be analyzed through a monetary policy rule of the following form:<sup>18</sup>

$$i_t^* = \beta_0 + \beta_1 \pi_t^* + \beta_2 (\pi_{t+12}^e - \pi_{t+12}^*) + \beta_3 (y_t - y_t^*), \quad (8)$$

where  $i_t^*$  is the desired nominal interest rate;  $\pi_t^*$  is the annual inflation target;  $\pi_{t+12}^e - \pi_{t+12}^*$  is the difference between the twelve months ahead expected annual inflation and the twelve

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<sup>17</sup> This prescription should be interpreted carefully in the case of an economy which is undergoing a disinflationary process, i.e., which has not converged to its long-run inflation target. In that case, monetary policy should have a clear restrictive bias at all times, independently of the nature of the shocks the economy faces.

<sup>18</sup> In general, the literature on monetary policy rules has found that simple specifications like (8), where the interest rate depends on the inflation expectations gap and on the output gap, are useful to characterize monetary policy.

months ahead annual inflation target (inflation expectations gap); and  $y_t - y_t^*$  is the output gap.

As explained by Clarida et al. (1999), setting interest rates in accordance to a rule like (8), where  $\beta_2 > 1$  and  $\beta_3 > 0$ , is consistent with inflation targeting principles and, in the long run, induces inflation to converge to its target and the output gap to zero. This is so, since, in response to a positive demand shock when both the inflation gap and the output gap increase, the rule recommends an increase in the real interest rate. However, when inflationary pressures come from a cost-push shock the recommendation is, in general, not to adjust the interest rate, since the increase in the inflation expectations gap is offset by a drop in the output gap. Nevertheless, if inflation expectations are contaminated by the shock, the increase in the inflation expectations gap will not be fully offset by the reduction in the output gap, and the recommendation is to raise interest rates as to avoid second round effects on prices.

To formally test whether monetary policy in Mexico has been consistent with the inflation targeting principles, a rule like (8) is estimated and the parameters  $\beta_2$  and  $\beta_3$  are tested statistically to be larger than one and zero, respectively. Given that the adjustment of interest rates by a central bank is usually only gradual, the approach proposed by Clarida et al. (1999) to estimate (8) is followed. It is assumed that the actual interest rate,  $i_t$ , is determined as a weighted average of the desired interest rate,  $i_t^*$ , and the actual interest rate observed in the previous period,  $i_{t-1}$ , plus an exogenous interest rate shock ( $v_t$ ) with zero mean:

$$i_t = (1 - \rho)i_t^* + \rho i_{t-1} + v_t, \quad (9)$$

where parameter  $\rho$  takes values between 0 and 1 and measures the degree of interest rate smoothing. Then, combining the desired interest rate (8) with the smoothing equation (9), the relationship to be estimated is the following:

$$i_t = (1 - \rho)(\beta_0 + \beta_1 \pi_t^* + \beta_2 (\pi_{t+12}^e - \pi_{t+12}^*) + \beta_3 (y_t - y_t^*)) + \rho i_{t-1} + v_t, \quad (10)$$

To estimate (10) the variables are defined as follows:  $i_t$  is the monthly average of the daily interbank interest rate;  $\pi_t^*$  is the annual inflation target for period  $t$  (defined as before);  $\pi_t^e$  represents twelve months ahead annual inflation expectations collected from two different surveys, one from Infosel (monthly average of weekly surveys) and another one from Banco de México; and  $y_t - y_t^*$  is the output gap (defined as before, see note 11). The sample period goes from 1998 to 2003. Afterwards, to analyze the sensitivity of the results to the different inflationary shocks, the exercise is also performed for two subsamples. The first one considers episodes one and two of monetary policy tightening, 1998:01-2001:12; while the second one episodes two and three, 1999:04-2003:12. Results are presented in Table 2.

**Table 2:**  
**Monetary Policy Rule\*\***

Sample:	Inflation Expectations from Infosel Survey			Inflation Expectations from Banco de México Survey		
	1998:01- 2003:12	1998:01- 2001:12	1999:04- 2003:12	1998:01- 2003:12	1998:01- 2001:12	1999:04- 2003:12
$\beta_0$	-5.06 (3.66)	-12.60* (3.92)	0.86 (1.70)	-4.44 (2.25)	-9.20* (3.10)	0.80 (1.54)
$\beta_1$	1.56* (0.44)	2.02* (0.44)	0.91* (0.22)	1.44* (0.31)	1.75* (0.38)	0.90* (0.23)
$\beta_2$	4.30* <sup>+</sup> (1.46)	5.14* <sup>+</sup> (1.30)	2.69* <sup>+</sup> (0.86)	5.03* <sup>+</sup> (0.86)	5.45* <sup>+</sup> (0.84)	3.06* <sup>+</sup> (0.88)
$\beta_3$	0.07 (0.65)	0.54 (0.78)	0.75* (0.39)	0.25 (0.43)	0.56 (0.52)	0.82* (0.37)
$\rho$	0.70* (0.16)	0.66* (0.19)	0.56* (0.15)	0.59* (0.13)	0.58* (0.14)	0.58* (0.10)
Adj. $R^2$	0.94	0.90	0.96	0.95	0.91	0.96
Obs.	72	48	57	72	48	57

<sup>+</sup> Statistically larger than 1 at the 95% confidence interval.

\* Significant at the 95% confidence interval.

\*\* Standard deviations in brackets.

The evidence shows that the process through which interest rates have been determined in Mexico is consistent with the inflation targeting principles. Results are robust for the two different sources of inflation expectations (Infosel and Banco de México surveys). The exercise for the full sample shows that the inflation gap coefficient,  $\beta_2$ , is statistically larger than one and that the coefficient for the output gap,  $\beta_3$ , is not statistically different from zero. These results suggest that from 1998 to 2003, the process through which interest rates have been determined has implied that whenever inflation expectations rise, nominal and real interest rates rise as well. This points to a stabilizing monetary policy rule that anchored inflation expectations and inflation around its target.

To understand why the coefficient on the output gap,  $\beta_3$ , is not significant, it is useful to consider the exercises for the two subsamples. Results for the first subsample are qualitatively the same as those for the full sample. However, in the second subsample, where the inflationary episode of 1998 is not included, results show that the coefficient on the inflation gap,  $\beta_2$ , decreases but remains larger than one, and the coefficient on the output gap,  $\beta_3$ , is positive and statistically different from zero. This could indicate that, given the magnitude of the cost-push shock in 1998, monetary policy mainly had to concentrate its efforts in anchoring inflation expectations and inflation, even at the expense of not being able to ease the drop in the output gap (Figure 4.2). This result also suggests that at the beginning of a disinflation process, in order to gain credibility in monetary

policy, it may be necessary to set interest rates according to a rule like (10), with a large  $\beta_2$  and with  $\beta_3$  close to zero.

To illustrate the previous argument, consider an extended monetary policy rule where the exchange rate is included explicitly:

$$i_t^* = \beta_0 + \beta_1 \pi_t^* + \beta_2 (\pi_{t+12}^e - \pi_{t+12}^*) + \beta_3 (y_t - y_t^*) + \beta_4 \Delta s_{t-1}, \quad (11)$$

where  $\Delta s_{t-1}$  represents the one period lag of the nominal exchange rate (pesos per dollar) monthly log difference. Again, to estimate this extended monetary policy rule (11), it is combined with the smoothing equation (9) and results are presented in Table 3.

**Table 3**  
**Extended Monetary Policy Rule\*\***

	Inflation Expectations from Infosel Survey			Inflation Expectations from Banco de México Survey		
	1998:01- 2003:12	1998:01- 2001:12	1999:04- 2003:12	1998:01- 2003:12	1998:01- 2001:12	1999:04- 2003:12
$\beta_0$	-5.53* (2.34)	-9.99* (2.75)	0.08 (1.40)	-4.79* (1.62)	-7.45* (2.33)	0.27 (1.56)
$\beta_1$	1.57* (0.31)	1.83* (0.34)	0.97* (0.19)	1.47* (0.24)	1.63* (0.29)	0.95* (0.22)
$\beta_2$	4.39*+ (1.00)	5.05*+ (0.95)	2.91*+ (0.85)	4.91*+ (0.67)	5.23*+ (0.68)	3.11*+ (0.87)
$\beta_3$	0.05 (0.50)	0.37 (0.55)	0.70* (0.36)	0.23 (0.37)	0.43 (0.44)	0.79* (0.38)
$\beta_4$	0.84* (0.31)	0.80* (0.37)	0.34 (0.26)	0.67* (0.22)	0.68* (0.30)	0.30 (0.29)
$\rho$	0.61* (0.20)	0.56* (0.24)	0.54* (0.15)	0.53* (0.16)	0.52* (0.17)	0.59* (0.10)
Adj. $R^2$	0.95	0.90	0.96	0.96	0.92	0.96
Obs.	72	48	57	72	48	57

+ Statistically larger than 1 at the 95% confidence interval.

\* Significant at the 95% confidence interval.

\*\* Standard deviations in brackets.

It is important to highlight that the estimates of the coefficients on the inflation gap,  $\beta_2$ , and on the output gap,  $\beta_3$ , are the same as in the previous specification. In the case of the coefficient on the exchange rate depreciation,  $\beta_4$ , the point estimate is positive and statistically significant in the first subsample, but not in the second one. Since the cost-push shock of 1998 was largely associated with a substantial exchange rate depreciation, this

result shows the importance of that particular shock in influencing coefficients  $\beta_2$  and  $\beta_3$  when the exercise is performed for the full sample.

The evidence presented in this section suggests that over the last years, monetary policy has been essential to the disinflation process experienced in Mexico. Although transparency in the implementation of monetary policy improved gradually, from the beginning of the process (1998) Banco de México maintained a clear restrictive bias and its response to inflationary shocks followed the main guidelines of inflation targeting. The Bank increased the monetary policy restriction when the economy experienced adverse cost-push shocks in 1998 and 2002-2003 that not only affected inflation, but also inflation expectations; and in 2000, when the economy experienced inflationary pressures coming from the demand side.

## **5. Conclusions**

This paper describes monetary policy in Mexico during the process that reduced inflation from close to 52 percent in 1995 to under 4 percent in 2003. After the 1995 crisis, one of the main objectives of economic policy was to guarantee that a fiscal dominance situation would not arise in the aftermath of the crisis. As measures intended to ensure a sounder fiscal position were put in place, inflation and inflation expectations started to decrease and monetary policy concentrated its efforts on pursuing long-run price stability.

Over the years, Banco de México gradually shifted monetary policy towards a fully fledged inflation targeting framework. As a result, the improved transparency in the implementation of monetary policy proved helpful in anchoring inflation expectations. However, it can be argued the success in reducing inflation was mainly due to the permanent restrictive bias signaled by the “corto” and to the appropriate response of monetary policy to different inflationary shocks. Actions taken by Banco de México during the disinflation process were consistent with those of a central bank that pursues price stability as its long-term goal, that is, with inflation targeting principles. In effect, monetary policy has become the nominal anchor of the Mexican economy.

The inflation targeting approach to the conduct of monetary policy constitutes a framework of constrained discretion within which monetary policy is implemented. The experience of Mexico is of particular interest because it represents a small open economy with a flexible exchange rate regime that reduced inflation in a sustainable way. To conclude, once a sustainable fiscal position has been established, an inflation targeting framework can be seen as a mechanism that imposes the necessary discipline on monetary authorities to conduct a successful disinflationary process. In particular, there should be no need to import the credibility from another central bank by anchoring the exchange rate.

Even if in Mexico inflation has been reduced considerably, the long-term objective of 3 percent has not been achieved yet. At present, the Mexican economy is experiencing inflationary pressures coming from increases in commodity (mainly food and energy) prices around the world. These pressures represent an immediate challenge for monetary policy. However, just as in the past, a monetary policy consistent with inflation targeting

principles is likely to prove useful in meeting this challenge and in the consolidation of long-run price stability.

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