Monetary policy and the transmission mechanism in Mexico[1]

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Abstract

This paper describes the evolution of monetary policy implementation in Mexico from 1995 to the present. At the beginning of this period, monetary policy was set in terms of a quantitative target. This framework then gradually evolved into one in which discretionary actions of monetary policy, aimed at reaching an inflation target, took on greater relevance. Additionally, we analyse two issues that have recently generated doubts about the effectiveness of the implementation of monetary policy: the use of borrowed reserves as a policy instrument and the effectiveness of monetary policy in affecting inflation by a channel other than the exchange rate. The main results indicate that the behaviour of the real interest rate has been determined by the traditional variables that guide the discretionary actions of any central bank and that this rate has affected aggregate demand and credit in a statistically significant way.

1.   Introduction

Since the adoption of the flexible exchange rate regime, as a result of the balance of payments crisis of 1994-95, monetary policy has become the nominal anchor of the economy. In 1995, there was little experience from countries with similar economic characteristics to Mexico that had a flexible exchange regime, which is why the current monetary policy framework is the result of an evolutionary process. This framework has been influenced by the experiences of small, developed economies with a floating regime and, more recently, by other Latin American economies that have adopted similar exchange rate regimes.

In Section 2 of this paper, we describe the evolution of the operation of monetary policy in Mexico from 1995 to the present. At the beginning of this period, monetary policy was set in terms of a quantitative target. This framework then evolved into one in which discretionary actions of monetary policy, aimed at reaching an inflation target, took on greater relevance. By analysing the evolution of the monetary base during the period that followed the crisis, we found that the relationship between the monetary base and prices has been very unstable. These dynamics severely limited the use of the former variable as an indicator of inflationary pressures.

In Sections 3 and 4, we focus on two issues that have recently generated doubts on the effectiveness of the implementation of monetary policy: the use of borrowed reserves as a policy instrument and the effectiveness of monetary policy in affecting inflation by a channel other than the exchange rate. We found, firstly, that in both cases the current monetary policy framework has been effective. This conclusion is sustained by the fact that the behaviour of real interest rates can be explained with the traditional variables that guide the discretionary actions of monetary policy of any central bank. Among these variables we could mention the gap between expected inflation and the inflation target and the output gap. Secondly, it is shown that besides its effect on the exchange rate, the real interest rate has

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affected inflation through the aggregate demand channel. Finally, in Section 5 the main conclusions of the paper are presented.

2.   Evolution of the monetary policy framework in Mexico: 1995-2000

The exchange rate and financial crisis that took place at the end of 1994 and during 1995 forced the authorities to adopt a floating exchange rate regime. The use of the exchange rate as the nominal anchor of the economy was therefore abandoned. As a result of the peso devaluation and the rise in inflation, the credibility of the Bank of Mexico was severely damaged. Criticism centred on the lack of transparency regarding the conduct of monetary policy, the dissemination of information and the lack of determination to tighten monetary policy before, during and immediately after the crisis.

Due to this criticism, and to the need to establish a visible and strict nominal anchor, in 1995 a limit on the growth of the central bank's net domestic credit was adopted. This limit was derived from an estimate of the growth of demand for monetary base and a null anticipated accumulation of international reserves. We should clarify that at the time neither that limit nor base growth were considered as intermediate objectives that could be used as quasi-automatic rules, given that their limitations were known by the authority. Nevertheless, due to the credibility crisis experienced by the central bank, the adoption of a visible monetary target was judged advisable. The limitations of monetary aggregates and their advantages in the circumstances that the Mexican economy was going through were expressed in the following way in the monetary programme for 1995:[3]

Most central banks have stopped setting quantitative targets for the evolution of their own credit or of monetary aggregates, such as notes and coins in circulation, M1 and others. This has been in response to technological changes and adjustments in financial regulations that have come about in the last few decades, and which have negatively affected the more or less stable relationship that used to exist between some of these aggregates and nominal GDP in years past.

Nevertheless, the current crisis of confidence in the national currency calls for the adoption of an extremely strict primary credit policy. The Bank of Mexico can do this by imposing a limit to the growth of its own domestic credit for the year.

This procedure can efficiently encourage economic agents' inflationary expectations to meet price projections contained in the economic programme adopted by the Federal Government - projections that correspond to the provisions of the Agreement to overcome the economic emergency.

In addition, as a result of the great uncertainty with respect to the evolution of the Mexican economy, it was considered extremely risky to use a short-term interest rate as an instrument of monetary policy. Therefore, with the aim of implementing an operating framework in which both the exchange rate and the interest rate were determined freely, the Bank of Mexico established the level of borrowed reserves (BR) as its instrument of monetary policy.[4] By setting this target, the Bank of Mexico sends signals to financial markets, without determining specific levels for interest rates or exchange rates.

Under this framework, the Bank of Mexico intervenes every day in the money market through auctions, credits, deposits, or through transactions with government paper, either directly or through repos. To that end, the central bank sets the amount to auction such that the aggregate level of borrowed reserves in the banking system starts the following day at the level determined beforehand.

In order to send signals regarding its monetary policy intentions, the Bank of Mexico determines the target level of BR for the start of the following working day. Thus, a zero BR target would indicate the intention of the central bank to satisfy, at market interest rates, the money demand and, therefore, to provide the necessary resources so that no bank is forced to incur overdrafts or to accumulate undesired positive balances at the end of the holding period. This would be indicative of a neutral monetary policy.

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[3]   *Exposition on the monetary policy, January 1 to December 31 1995*, pp 53-54.

[4]   For a detailed explanation of this mechanism, see *Annual Report*, Bank of Mexico, 1997, Appendix 4.

A negative BR target, a *corto* (to leave the money market short), would indicate the central bank's intention not to provide the banking system with sufficient resources at market interest rates, thus forcing one or several credit institutions to obtain part of their required reserves through overdrafts on their current accounts. This, abstracting from other influences, would cause a rise in interest rates, since the institutions will try to avoid paying the higher overdraft rate by raising funds in the money market. This would send the signal to the market that the Bank of Mexico has adopted a restrictive monetary policy stance.

Therefore the Bank of Mexico always provides the credit needed to fully meet the demand for money, even when it adopts a negative accumulated balances target. In this last case, part of that credit is granted at a penalty rate, in the form of an overdraft on the current account of one or more banks.

In 1995, as in previous years, the Bank of Mexico defined an annual inflation target (December 1994-December 1995) which, after the modifications made to the economic programme during the first quarter of the year, was set at 42%.

In addition, in the same year the Bank of Mexico encouraged the development of the futures and options markets for the Mexican peso and established a new information policy, in order to ensure that economic agents could count on these financial instruments to cover themselves against the greater exchange volatility and that they had the necessary information to follow and monitor the actions of the monetary authority.

During 1996 and 1997, this monetary policy framework was maintained. In 1996, the limits on the growth rate of domestic credit, on the anticipated accumulation of international assets and the growth forecast for the monetary base were presented quarterly, while for 1997 the monetary programme announced the anticipated daily path of the monetary base during that year.
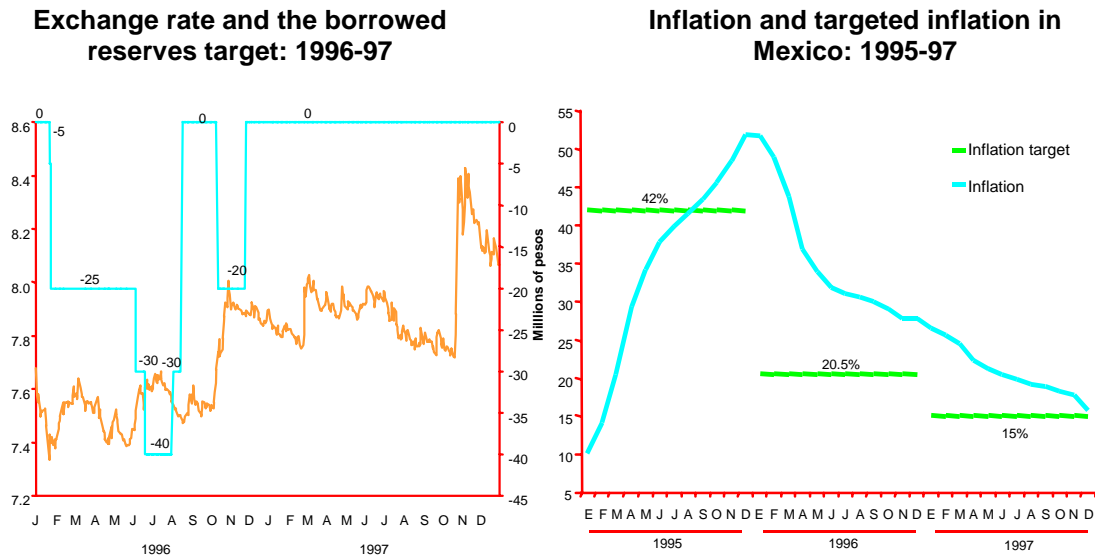
The well established, attested seasonal behaviour that monetary base demand exhibits generated the perception that at certain times of year monetary policy was very expansive. For this reason, it was decided that the monetary programmes and the annual reports of those years would include quarterly and daily forecasts.[5] By doing this, it was easier to show that these seasonal increases were consistent with the annual forecast and did not represent a relaxed monetary policy stance, avoiding the confusion associated with seasonal increases in the monetary base. Nevertheless, increasing the frequency of these commitments raises the possibility of failing to fulfil them due to transitory or fortuitous events, since the relationship between money and nominal income is even more unstable in the short term. The inflation targets determined by the Bank of Mexico for 1996 and 1997 were 20.5% and 15% respectively.

Regarding the discretionary actions of the Bank of Mexico during these years, the application of the corto was oriented towards restoring stable conditions in financial markets when these faced disturbances. Once order in these markets was restored, the target for BR returned to zero. In this sense, the annual inflation target played an important role at the beginning of the year, by guiding the expectations of economic agents, and the discretionary actions of monetary policy taken during the year were oriented towards reducing the impact of unanticipated financial disturbances on the inflation path.

During this period, inflation came down from 52% in 1995 to 15.7% in 1997. Nevertheless, as shown in Graph 1, due to the great inflationary uncertainty associated with the high level of inflation, the annual targets for 1995 and 1996 were not reached. However, in 1997 inflation was only 0.7 percentage points above the proposed target.

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[5] 1997 monetary programme.

Graph 1

Exchange rate and the borrowed reserves target: 1996-97	**Inflation and targeted inflation in Mexico: 1995-97**

In 1998, the monetary policy framework began a gradual transition towards an explicit inflation targeting framework. In the process, the behaviour of the monetary base has become less relevant in the analysis of inflationary pressures, and the short- and medium-term inflation targets have increased their importance. Additionally, the focus of discretionary monetary policy has shifted towards the attainment of the short- and medium-term inflation targets.

Although the monetary programme for 1998 was similar to the previous one, some changes suggest the beginning of the transition mentioned in the previous paragraph. In particular, this document described what the reaction of the monetary authority would be if different external and internal disturbances were to occur. Another indication of this transition was the increase in the corto, during November of that year when, as a result of the Russian crisis and the fall in the oil price, inflation expectations for the next year were way above the target. The intention of this monetary policy action was:

To try, through the conduct of monetary policy, to bring about a rapid adjustment in the recent trend of annual inflation. For that reason, the Board of the Central Bank has decided that, from now on, policy actions will be taken to ensure that we can reach the inflation target of 13% for December 1999. Thus, in order to offset the process of revision of inflationary expectations for 1999, to avoid disorderly price reactions and to be able to reach the inflation target of 13% for next year, the Board of the Bank of Mexico has decided to increase the monetary restriction, raising the amount of the "corto" from 100 million to 130 million pesos.[6]

This was the first occasion on which the corto was increased as a preventive measure in order to bring about the appropriate monetary conditions for achieving the inflation target for the following year.

The monetary programme for 1999 set a target inflation ceiling of 13%. This programme also envisaged a gradual convergence, over the next five years, towards the rate of inflation of Mexico's main trading partners. Recently, this long-term objective has become more explicit and currently the long-term goal of monetary policy is to reach an inflation target of 3% in 2003. The implementation of monetary policy continues to move towards anticipatory management in which the lags that affect the evolution of prices are recognised and, therefore, the monetary authority needs to act in a preventive way to induce behaviour consistent with the proposed targets. For 2000 an inflation target of less than 10% was set. In October 1999, in addition to the inflation targets for 2001 (6.5%) and 2003 (3%), an indication with respect to the target that would be adopted for 2002 (4.5%) was announced.

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[6] Bank of Mexico *Press Bulletin*, no 139, 30 November 1998.

During the period 1998-2000, the trend reduction in the importance of the targets for the growth of the monetary aggregates has continued, in response to the unstable relationship experienced between the monetary base and prices during the period. Although money demand estimations indicate the existence of a long-run stable function, the instability in the short term has prevented its use as an intermediate target. Recent studies (Garcés (2000)) have identified a long-term stable demand for monetary base for the period 1982-2000. In addition, the estimated long-term elasticities are consistent with a Baumol-Tobin demand for money. Nevertheless, the deviations present in the short term with respect to this long-term demand for monetary base are high (nearly 7.9%) and are eliminated over an extended period of time (50% in four quarters and 95% in sixteen quarters). Therefore, although over a long horizon this relationship holds, over an annual period it shows considerable deviations. The negative relationship between the growth of the monetary base and inflation present in the 1995-99 period is shown in the graph below.

Graph 2

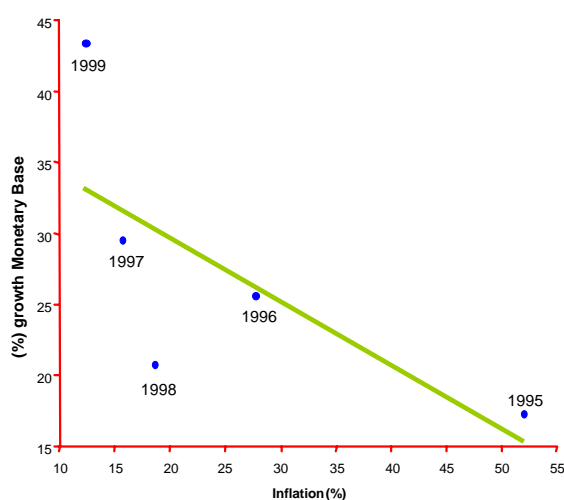**Annual growth of monetary base
and inflation: 1995-99**

Table 1 shows that in those years in which the inflation target was reached, the monetary base growth projection was significantly different from the observed outcome, whereas in those years in which inflation exceeded the target, the growth of the monetary base was similar to that forecast. In this table, it can also be seen in forming future inflationary expectations, economic agents consider the previous fulfilment of the inflation targets and not if the monetary base targets were reached.

Table 1
Monetary base and inflation
(percentage)

	Inflation objective	Observed inflation	Targeted monetary base growth	Observed monetary base growth	Inflation expectations at the start of the year
1995	42.0	52.0	29.1	17.3	29.9
1996	20.5	27.7	28.6	25.7	28.6
1997	15.0	15.7	24.5	29.6	18.2
1998	12.0	18.5	22.5	20.8	13.2
1999	13.0	12.3	18.1	43.5	16.5
2000	10.0		20.6		10.6

Due to the large deviation between the observed and the anticipated growth of the monetary base in 1999, the monetary programme for 2000 explained why the importance of these elements in the monetary policy framework was reduced.

Going deeper into this last point, it is important to highlight that during 1999 the sharp increase in the money base had two causes. First, the process initiated in 1997 continued once the rate of inflation had re-established a clear downward trend. As shown in Graph 3, the proportion of money to GDP registered in 1998 and 1999 was less than that observed in 1991 and 1992, when similar levels of inflation were experienced. It can also be seen, by looking at the relationship between the annual inflation rate and the money/GDP ratio, that the increase in the latter only begins once the reduction in the inflation rate has been consolidated. Second, it becomes clear from the graph that the reduction of this ratio happens significantly faster than its increases. Therefore, as the disinflation process continues, it is reasonable to expect that this ratio will keep growing.

Graph 3
**Monetary base/GDP ratio
and annual inflation**
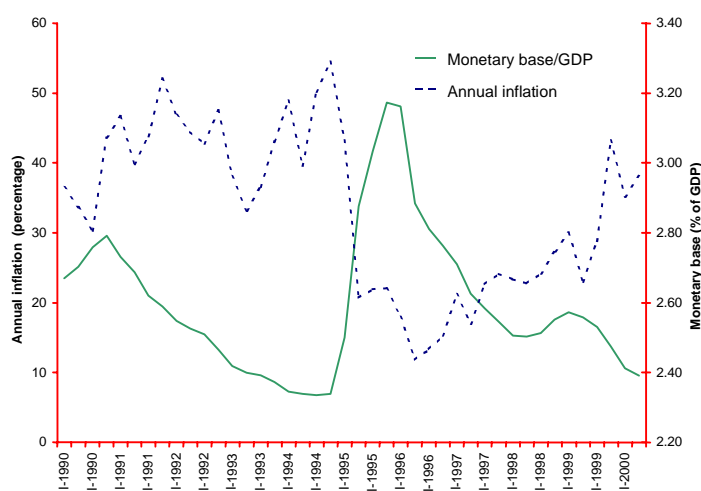
If an excess of monetary base supply were to be deliberately generated, this would be reflected in the behaviour of financial markets. In particular, the economic agents would want to get rid of the excess money by acquiring assets denominated in foreign currency, thereby causing an exchange rate depreciation. As shown in Graph 4, the gap between the observed and the programmed evolution of the monetary base that was experienced in 1999 and in some months of 2000 can hardly be associated with exchange rate depreciations.

Graph 4

Deviations of monetary base and exchange rate

1999   2000
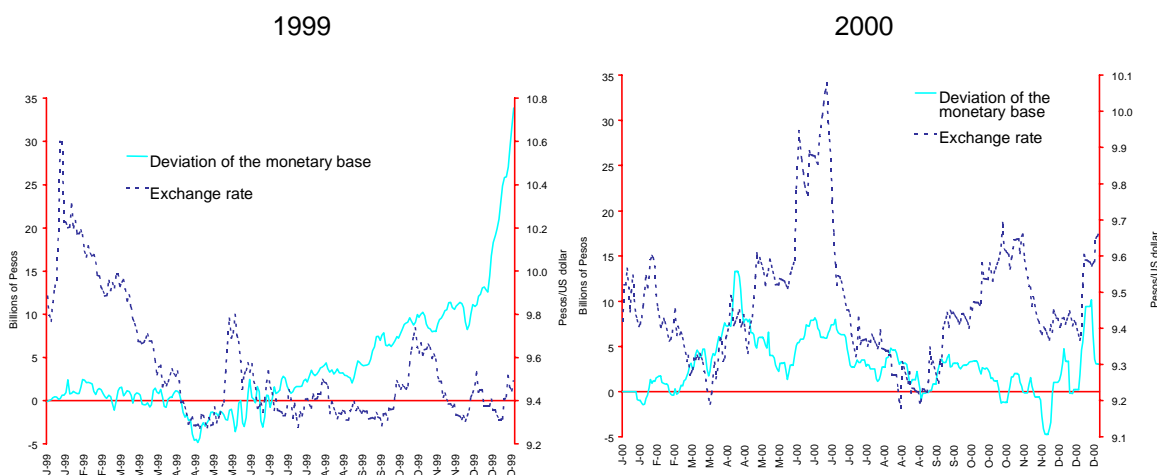
The absence of a stable relationship between these aggregates and the inflation rate has motivated the great majority of central banks to reduce the importance granted to the evolution of these variables in the analysis and evaluation of inflationary pressures. Therefore, this has discredited the mechanical use of these variables for the conduct of monetary policy. Several authors, for example Mishkin (2000), have described in detail the international experience with the use of monetary aggregates as intermediate targets. The empirical evidence supporting the decision by several central banks to reduce the importance of monetary aggregates in the analysis of inflationary pressures is shown in Graph 5, where the growth rates of the monetary base and the general price index for several developed countries are presented. The graph shows how the relationship has not been stable - mainly in the short term - and it can be seen that, on several occasions in those periods in which inflation diminishes, the growth rate of the monetary base increases considerably.

Graph 5

Growth rate of base money and inflation: international experience
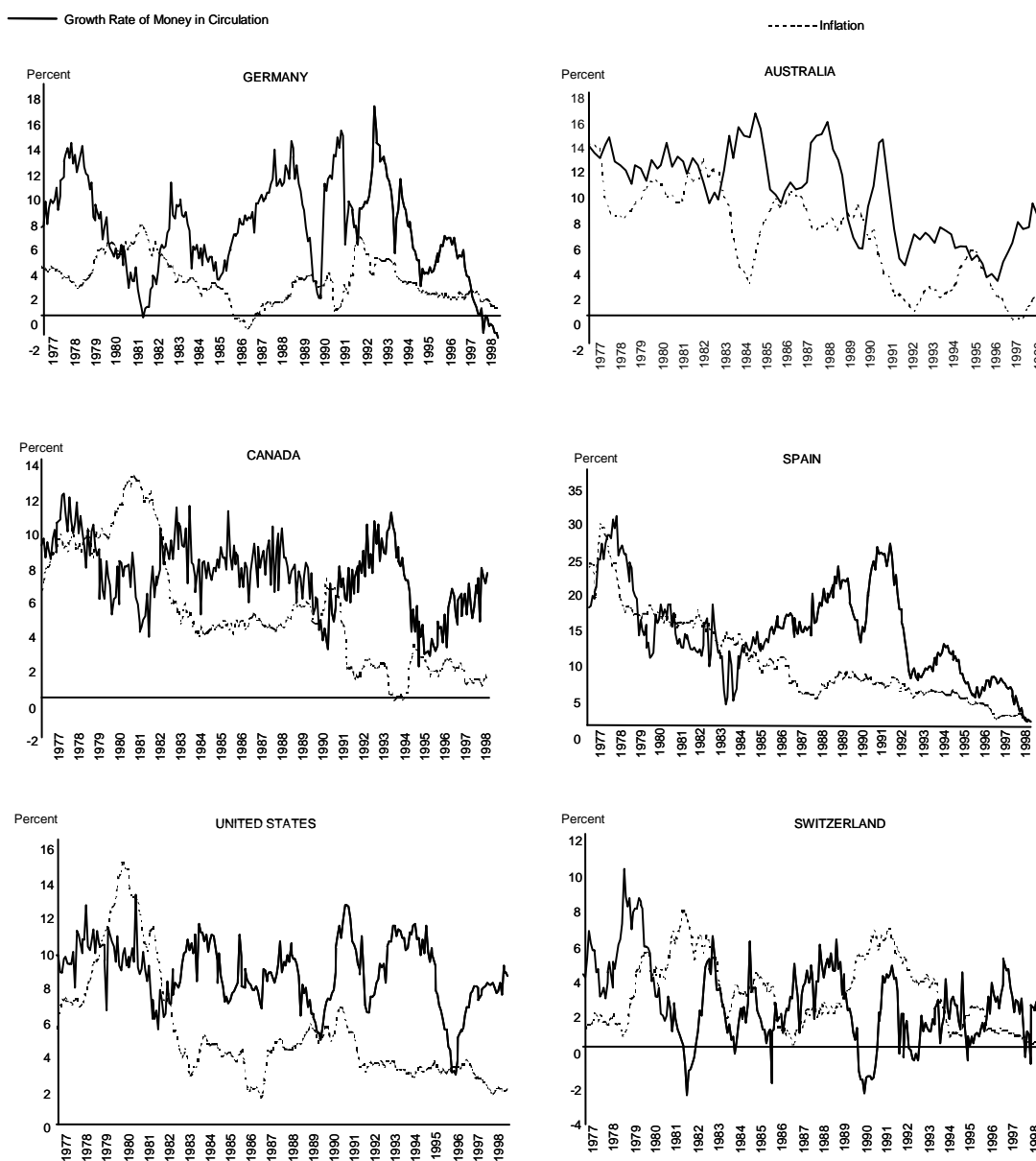
Thus, both international and national experience indicate that the inflationary phenomenon is so complex that it cannot be anticipated exactly from the behaviour of only a few variables.

Consequently, at the moment the Bank of Mexico adjusts its monetary policy stance when the need arises to modify the monetary conditions so that it will be able to achieve the inflation target. In particular, the Bank will use the corto, adopting a more restrictive monetary policy, mainly in the following circumstances:

1.   When it detects future inflationary pressures inconsistent with the achievement of the adopted inflation targets and if, in turn, inflationary expectations have deviated considerably from the inflation target;

2.   When inflationary shocks appear. In particular, monetary policy will try in every circumstance to neutralise the indirect effect of exogenous shocks on prices, and will sometimes take preventive action to partially offset the direct inflationary effects of the movements of key prices in the economy. The ultimate aim is that the necessary adjustments of relative prices affect the CPI only moderately, increasing its level but avoiding a deterioration in inflationary expectations;

3.   When it is necessary to restore orderly conditions in the exchange and money markets.
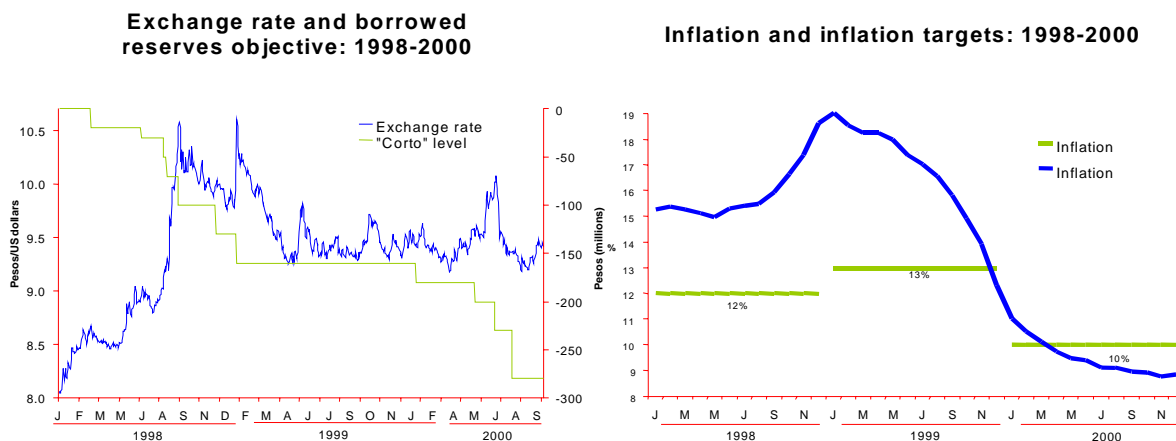
In the absence of a clear short-term relationship between monetary base growth and inflationary pressures, up to 1999 economic agents had little information on which to base an evaluation of the conduct of monetary policy. Therefore, in 2000 the Bank of Mexico considered it appropriate to extend its instruments of communication with the public by publishing a quarterly inflation report. In this report, the evolution of inflation and the application of monetary policy are described and analysed, and a balance of risks in terms of the future path of the growth of prices is discussed.

The introduction of a medium-term inflation target, the extension of the mechanisms of communication with the public, the reduced use of monetary aggregates and the reduction of the rate of inflation have brought about an important change in the implementation of monetary policy in Mexico.

At present, monetary policy actions are aimed at influencing monetary conditions and expected inflation in order to achieve convergence between these and the proposed targets. Thus, during most of the period 1998-2000, when public inflation expectations were greater than the proposed targets, the authority had to intensify the restrictive stance of monetary policy. Therefore, during this period, the monetary policy moves (increases in the corto) towards greater tightening have been longer-lasting (Graph 6). This contrasts with the experience in 1996-97, when in the face of a gap between expectations and targets, the corto was only used to calm the markets, and thus had a transitory character.

Although in 1998, due to the external disturbances that the Mexican economy was experiencing and to the programmed increases of public goods prices, inflation was way above target, in 1999 and 2000 it ended below the targets originally established (Graph 6).

Graph 6

Exchange rate and borrowed reserves objective: 1998-2000

Inflation and inflation targets: 1998-2000

The change in the reaction function of the monetary authority can be illustrated by comparing monetary policy actions and the evolution of interest rates in 1997 and 2000. In these two years, the Mexican economy experienced a favourable external environment, the inflation rate was similar to the targets proposed and economic growth surpassed the original forecasts (observed growth was 7% in both years).

In addition, in the second half of these two years, the evolution of expected inflation for the following year and contractual wage settlements were inconsistent with the proposed targets for the following year, as illustrated in Graph 7.

Graph 7

Inflation expectations, contractual wages and

**inflation target for the next year**
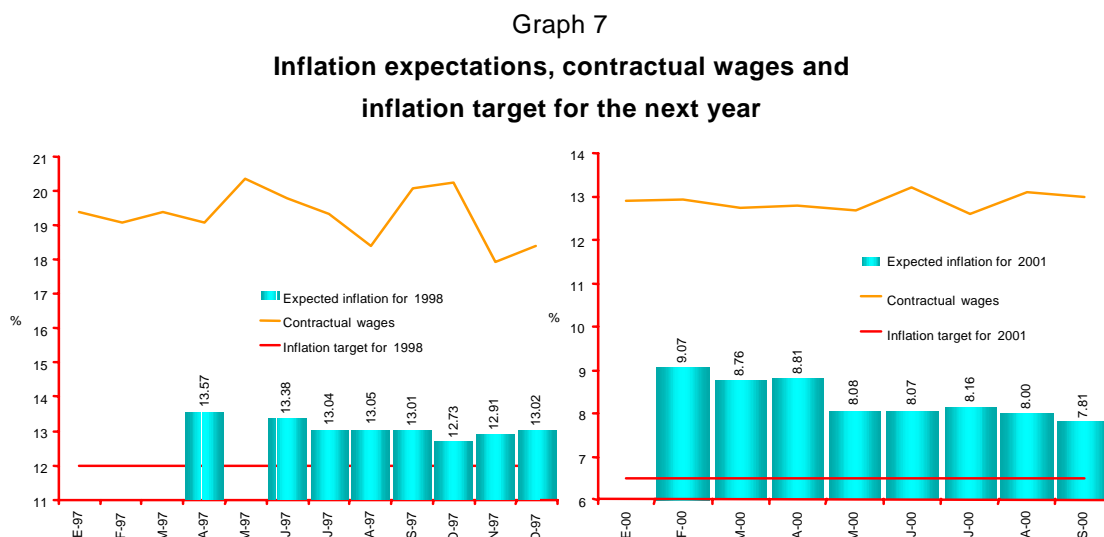
Under this scenario, the monetary authority did not respond during 1997 and the gap between real interest rates denominated in national currency and foreign currency diminished over the year, later registering a substantial increase in reaction to the intensification of the Asian crisis in November of that year. In contrast, during 2000, when inflationary pressures appeared to be endangering the future reduction of inflation, the monetary authority progressively increased the corto and induced a significant and constant increase in the gap between domestic and foreign real interest rates from April of that year. This can be clearly observed in the evolution of the spread between the real interest rate in pesos for one-month government bonds (Cetes) and the gross yield of the UMS26 bond. As observed in Graph 8, this spread was greater on average during 2000 than during 1997. In addition, it increased in the second half of the year in response to the restrictive actions of monetary policy. In contrast, in 1997 this differential[7] was falling for much of the year, only increasing in response to the Asian crisis when the currencies of Hong Kong and Korea were attacked. As can be seen in this graph, once this pressure diminished, the interest rate resumed its declining trend. This change in the reaction function of the monetary authority will be demonstrated more formally in the following sections of the document.

In this transition towards explicit inflation targets, the effectiveness of monetary policy in Mexico has frequently been questioned. In particular, some doubts have emerged about the optimality of the instrument used and about the operation of the transmission mechanisms. These subjects are analysed in the following sections.

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[7] Due to the great influence of external rates on domestic ones, this spread measures the movement of rates denominated in national currency once the effect of external rates has been removed.

Graph 8

Real rate on Cetes (one month) - gross yield UMS 26

1997   2000
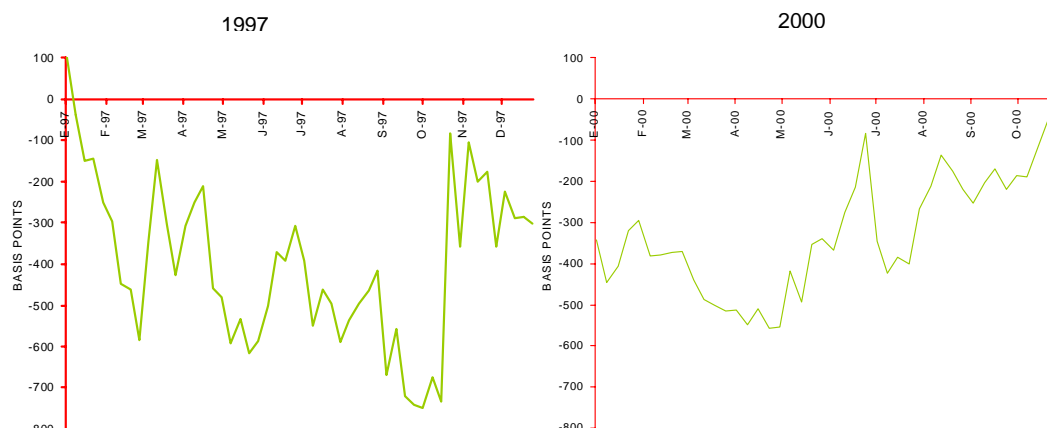
3. Monetary policy implementation in Mexico

Currently, most central banks recognise as their main policy objective the achievement and maintenance of price stability. Throughout history, these institutions have used different variables to accomplish this objective:

1. the interest rate charged to commercial banks;

2. the reserve requirements that determine the proportion of liabilities that commercial banks have to maintain as deposits in the central bank;

3. the terms on which the central bank grants more liquidity to the market.

The management of monetary policy consists in defining the level of the instrument that, given the transmission mechanism of monetary policy, is consistent with the achievement of the target. It is not hard to recognise that through any of the instruments listed above the central bank is able to influence, directly or indirectly, the determination of the short-term market interest rate.

The tools of monetary policy that modern central banks use can be divided into two groups:

1. interventions in the money market to fix the overnight rate or to limit its fluctuation within a band;

2. management of money market conditions through quantitative restrictions.

For example, the US Federal Reserve (Fed) and the Bank of England work with mechanisms geared towards maintaining a target rate around a given level. Other central banks, such as the European Central Bank and the Bank of Canada, hold the official rate within a band. This rate is defined in terms of a penalty rate, which is used in the overnight market, and of a floor defined by the rate which is paid on the deposits that commercial banks hold at the central bank.

As can be seen from Table 2, nowadays in most countries monetary policy is implemented through the definition of a target for the short-term interest rate. In the past, however, several central banks have operated through adjustments in the amount of resources they provide to the system. This was the case with the "non-borrowed reserves" target regime implemented by the Fed at the beginning of the 1980s, and the regime of "settlement balances" used in New Zealand up to March 1999.

Table 2
Interest rates used for monetary policy actions

Country	Interest rate used	Term
United States	Overnight federal fund rate	1 day
Canada	Bank rate	1 day
Australia	Cash rate	1 day
New Zealand	Official cash rate	1 day
England	Repo rate	2 weeks (average)
Sweden	Repo rate	7 days
Japan	Official discount rate	1 day
Korea	Overnight fund rate	1 day
Israel	Nominal effective interest rate	1 day
Poland	Discount credit rate	1 day
Brazil	Base rate	1 day
Colombia	Intervention rate	7 days
Chile	Monetary policy rate	1 day
European Monetary Union	Refi rate	2 weeks

Under the non-borrowed reserves target system, the Fed auctioned a given amount of non-borrowed reserves daily, while the rest of the funds that the system required in the short term were provided at some penalty rate through the discount window. In this way, each time the central bank reduced the amount of non-borrowed reserves, more funds were available at the discount rate, forcing an increase in the short-term interest rate. After 1982, the Fed returned to the implementation of monetary policy based on an objective for the federal funds rate.[8]

Under the system of settlement balances in New Zealand, the commercial banks could hold positive balances in their account at the central bank that paid a lower return than the market's (300 basis points in 1998) and zero for every balance higher than a certain limit. No overdrafts were allowed. The only source for additional immediate liquidity were reserve bonds, since the central bank was willing to buy all bonds with an effective maturity of less than 28 days at discount. By taking the bonds at discount, the central bank imposed a penalty rate (equal to 90 basis points in 1998) which was charged at the expiration of the discounted paper.[9] Thus, financing through this mechanism was more expensive than through the use of their balances in the account held at the central bank. These balances constituted the demand for settlement balances. The central bank performed its open market operations in such way that the financial system closed with a positive balance equal to the pre-established objective, which constituted the target for settlement balances. By reducing this target, the central bank generated greater competition for funds, imposing upward pressure on the short-term interest rate. In March 1999, the implementation of monetary policy in New Zealand was changed from this system, in which the central bank indirectly manipulated market conditions through the mechanism described, to a system in which the central bank fixes an objective for the interest rate.

Under the regimes of non-borrowed reserves and settlement balances, as well as under the BR framework implemented in Mexico, the central bank fixes an objective for the amount of funds it provides at market interest rates and/or at a penalty rate, affecting the interest rate only indirectly. In Mexico, under the BR targeting, explained in Section 2, the central bank manipulates the amount of funds provides to the market so that a certain amount (corto) will be granted at the penalty rate and the rest of the funds at the market rate. The situation was similar in the case of the settlement balances system, where, by reducing the objective, the central bank pushed the commercial banks to satisfy their extra liquidity needs through rediscount operations. Finally, under the non-borrowed reserves regime, the Fed fixed an objective for funds provided at the market rate, and the rest of the funds were provided at the penalty rate.

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[8] For a detailed description of the instruments used in the United States, see Walsh (1998).

[9] The penalty for taking a bond with an effective maturity of three days was 270 basis points in 1998. Given the need of commercial banks to finance operations within one day, this alternative could become very expensive.

3.1 Advantages and disadvantages of a quantitative instrument vs an interest rate instrument

When defining the instrument of monetary policy, a central bank takes into account internal and external factors. On the one hand, the instrument determines the transparency of the monetary policy signal, as well as its effectiveness in affecting the short-term interest rate, the rest of the yield curve, the prices of other assets, the exchange rate and future expected inflation. This determines its impact on the components of aggregate demand and on the setting of prices in the economy. On the other hand, in an open economy with a flexible exchange rate, the definition of the instrument determines how external volatility translates into changes in the interest rate or the exchange rate.

Among the advantages of an instrument that affects money market conditions through a quantitative restriction is the inclusion of all the information available to market participants and the central bank on the determination of interest rates. This happens because the instrument only works as a signal that interacts with the action taken by market agents. Under volatile conditions, the preceding argument implies that the short-term interest rate changes automatically, making it very flexible and allowing the distribution of external shocks between changes in it and in the exchange rate.

On the other hand, the quantitative instrument is compatible with different levels of the interest rate as it simply defines the amount of funds that the central bank offers to the commercial banks at the penalty rate, and this last rate is defined as a function of the market interest rate. That is why, by being compatible with different levels of interest rates, its effect on them is more uncertain, because it depends on the conditions that prevail in the financial markets.

The implementation of monetary policy based on an objective for the short-term interest rate represents a much more direct signal. In practice, the use of this instrument has taken the form of gradual action by central banks. This can happen because, in situations with uncertainty, mistakes in the calculation of the target rate can have consequences for the central bank's ability to control inflation. Besides, frequent variations in the target interest rate imply constant changes of direction in the monetary policy stance, and this could generate confusion in the market.[10]

Next, we analyse the behaviour of the target interest rate in countries in which the central bank uses this as a policy instrument. Even though in Mexico the monetary policy instrument has not been the fixing of a target rate, we present a measure of what could have been the "target" rate with the intention of comparing it with the implementation of monetary policy observed in other countries.

To estimate the "target" rate in Mexico, we assume that it would have been equal to the weekly average of the overnight rate. We also consider that the "target" rate would have stayed constant if the weekly change, in absolute value, of the overnight rate were less than 150 basis points. Finally, when this change is greater than 150 basis points, the new "target" rate becomes equal to last week's average overnight rate. Graph 9 shows the behaviour of the observed overnight rate and the estimated "target" rate based on this methodology. As can be seen, the behaviour of the estimated "target" rate for Mexico would have been characterised not only by frequent movements, but also by constant changes in the direction of the monetary policy stance.

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[10] Some authors have analysed the gradualism of United States monetary policy. Among them, Cukierman (1991) argues that one of the reasons why the Fed has an element of smoothing of movements in the interest rate in its reaction function to protect the banking sector from financial crises. On the other hand, Sack (1998) finds that this element of gradualism in the Fed's reaction function can be explained by introducing uncertainty in the parameters of a structural model for the economy.

Graph 9

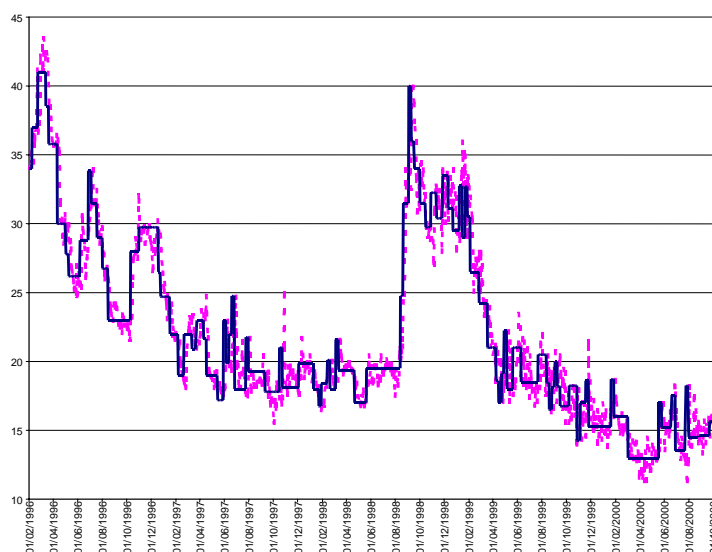**Overnight interest rates and "hypothetical objective"**

Table 3 shows changes observed in the target rate of a group of countries, and the estimates for Mexico based on the methodology described above. From these results it is possible to see that the monetary policy of central banks that use a target rate as their instrument is characterised not only by gradual movements in the rates, but also by limited changes in direction. When we compare this behaviour with that of the estimated "target" rate for Mexico, we see that to approximate the observed fluctuations in the overnight rate, the Bank of Mexico would have had to make a large number of modifications to the "target" rate.

The last row of Table 3 shows the frequency of the changes in the direction of the target rate. As we can see, in most countries the direction of monetary policy has changed with a probability of between 9% and 30%. Whereas, based on the estimation for Mexico, this number would have been 57%. This means that more than half of the changes in the estimated "target" rate would have caused a change in the direction of the monetary policy stance.[11]

It should, however, be noted that if the observed modifications in the overnight rate had not been made, that probably would have been reflected in more abrupt changes in the exchange rate. This, and the high pass-through of exchange rate movements to prices, would have affected the path of inflation.

Therefore, the observed frequency of changes in the conditions of the money market in Mexico has been necessary to keep the inflation rate on a path consistent with the central bank target, fundamentally because of two factors:

(a)   volatility in the yield of Mexican bonds denominated in foreign currency in the international capital markets (foreign bonds), and

(b)   the effect of exchange rate changes on the behaviour of prices.

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[11]   When the exercise is carried out using the behaviour of the 28 day Cetes, the number of changes in the "target" rate during the year is more similar to the average observed in other countries. Even so, the probability of a change in direction is 52%, which is still greater than that observed in other countries.

Table 3
Changes in target rate

	Australia		Germany[1]		Israel		Canada		United Kingdom		United States		Mexico	
	Changes		Changes		Changes		Changes		Changes		Changes		Changes	
	Total	Direction	Total	Direction	Total	Direction	Total	Direction	Total	Direction	Total	Direction	Total	Direction
1996	3	(+)0 (-)3	1	(+)0 (-)1	9	(+)4 (-)5	16	(+)4 (-)12	4	(+)1 (-)3	1	(+)0 (-)1	17	(+)6 (-)11
1997	2	(+)0 (-)2	0	(+)0 (-)0	4	(+)1 (-)3	4	(+)4 (-)0	5	(+)5 (-)0	1	(+)1 (-)0	19	(+)8 (-)11
1998	1	(+)0 (-)1	0	(+)0 (-)0	10	(+)2 (-)8	5	(+)2 (-)3	4	(+)1 (-)3	3	(+)0 (-)3	21	(+)9 (-)12
1999	1	(+)1 (-)0	2	(+)1 (-)1	6	(+)0 (-)6	3	(+)1 (-)2	6	(+)2 (-)4	3	(+)3 (-)0	26	(+)11 (-)15
2000	4	(+)4 (-)0	6	(+)6 (-)0	8	(+)0 (-)8	3	(+)3 (-)0	2	(+)2 (-)0	3	(+)3 (-)0	11	(+)6 (-)5
Probability of change in the target rate	9		11		14		26		14		27		57	

[1] For 1999 and 2000 the source is the European Central Bank.

The instrument of monetary policy imposes conditions so that the adjustment to internal as well as external shocks will be distributed between fluctuations in interest rates and exchange rates. Thus, in the presence of high pass-through, the necessary condition for keeping inflation online with the central bank's target is the distribution of the reaction to the shocks between the interest rate and the exchange rate. In the following two sections, we analyse how the implementation of monetary policy in Mexico has been conditioned by the two factors mentioned above.

3.2 The volatility of the external rate

To analyse the effect of the volatility of the yield of foreign bonds on domestic money market conditions, it must be considered as being transmitted through movements in the exchange rate or in the interest rate depending on the instrument of monetary policy. This can be seen in a simple way from the equation of the interest rate parity condition. Under the assumption of perfect capital mobility we have:

$$i_t = i^*_t + (s_{t+1} - s_t)$$

where i is the national interest rate, i^* is the yield of a Mexican government bond denominated in dollars, and $s_{t+1} - s_t$ is the expected exchange rate depreciation (or appreciation). Solving for i^* and calculating the variances on both sides of the equation, we find that the sum of the variance of the interest rate and the exchange rate depreciation is equal to the variance of the yield of the bond in dollars.[12]

$$\text{var}(i) + \text{var}(\Delta s) \pm \text{cov}(i, \Delta s) = \text{var}(i^*)$$

The equation above implies that when the central bank fixes the short-term interest rate, the external volatility will be transmitted mainly to the exchange rate market. On the other hand, when the central bank allows fluctuations in the short-term interest rate the external disturbances are distributed between adjustments in both variables. Table 4 shows the standard deviation of the yields of foreign bonds. As can be seen, this measure of the yield's volatility has been much greater for the Mexican bonds than for the securities of other countries with freely floating exchange regimes.

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[12] The yield of the bonds the government places in other countries includes the external interest rate and the country risk.

Table 4

**Standard deviation of the yield of government bonds
denominated in foreign currency**

(basis points)

	Mexico	**Canada**	**Australia**	**New Zealand**
97 I	20	9	10	…
97 II	15	7	8	7
97 III	11	8	8	8
97 IV	28	7	7	7
98 I	10	8	10	8
98 II	11	5	5	7
98 III	54	7	7	6
98 IV	30	13	15	11
99 I	31	10	11	10
99 II	21	11	10	9
99 III	14	11	9	9
99 IV	13	9	10	9
00 I	21	8	8	8
00 II	23	14	14	13
00 III	12	6	9	6

In order to analyse the effect of this high variability of the external rate on the behaviour of the exchange rate and the interest rate, Tables 5 and 6 compare the volatility of these variables with those observed in other countries. As we can see from both tables, exchange rate volatility in Mexico has not been significantly different from that in other countries. Nevertheless, the volatility of the overnight rate has been considerably greater than that in other countries (Table 6).

Table 5

Volatility of exchange rate depreciation

(percentages)[1]

	Germany[2]	**United Kingdom**	**Canada**	**Australia**	**New Zealand**	**Mexico**
96 I	6.4	5.8	3.7	6.2	5.4	6.4
96 II	6.6	5.4	3.1	6.3	5.8	5.1
97 I	9.8	8.5	4.8	7.4	6.0	4.7
97 II	9.8	8.0	4.2	10.3	8.6	10.7
98 I	8.1	7.1	4.3	11.9	12.5	6.7
98 II	9.2	7.3	7.0	15.0	15.1	11.1
99 I	8.9	6.9	5.7	9.9	9.5	9.9
99 II	10.0	7.3	5.2	8.6	10.1	7.1
2000 Q1	12.2	7.3	5.0	10.7	11.2	5.9
2000 Q2	12.5	8.1	5.1	11.4	13.5	7.2
2000 Q3	11.0	8.1	4.5	10.7	11.4	9.1

[1] Variation coefficients for the exchange rate of each country vis-à-vis the US dollar.   [2] For 1999-2000, the source is the European Central Bank.

Table 6
Volatility of short-term interest rates
(percentages)[1]

	Germany[2]	United Kingdom	Canada	Australia	New Zealand	Mexico
97 I	4.2	0.7	0.2	0.6	3.5	20.6
97 II	5.0	1.0	0.6	0.7	5.0	7.1
98 I	3.1	0.5	0.7	0.1	3.2	5.1
98 II	2.0	2.2	1.3	0.2	14.4	57.9
99 I	5.8	3.7	0.2	0.1	5.7	20.6
99 II	0.5	1.9	0.2	0.1	0.3	5.3
2000 Q1	0.2	5.7	0.4	0.7	1.0	6.2
2000 Q2	0.9	3.0	0.6	0.4	0.9	9.1
2000 Q3	0.5	3.5	0.0	0.1	0.1	11.5

[1] Variation coefficients. [2] For 1999-2000, the source is the European Central Bank.

If Mexico had fixed the interest rate, given the international experience and assuming that the central bank had not sent ambiguous signals to the markets, the variability of the overnight rate would probably have been smaller. Nevertheless, in the light of the arguments presented above, this would have caused an increase in exchange rate volatility, which, due to the high pass-through, could have resulted in higher inflation.

The previous point can be illustrated with the experience of New Zealand, a country for which, as we saw in the first section, the monetary policy instrument until February 1999 was similar to that used in Mexico. As we can see from Table 6, the adoption of an interest rate instrument in March 1999 caused a fall in the variability of rates while, as observed in Table 5, the exchange rate volatility during 1999 and 2000 was considerably greater than that observed in 1996 and 1997. In this comparison, the period from the second half of 1997 to the end of 1998 was excluded due to the high volatility generated by the Asian and Russian crises.

The fall in the variability of the interest rate in New Zealand could also have resulted from a fall in the volatility of the external rate, country risk or the terms of trade. In order to control for these effects of the external environment, we took the observed variability of the interest rate and the exchange rate of Australia, an economy with very similar characteristics. Referring back to Table 6, we can see that since the adoption of the interest rate instrument in New Zealand in March 1999, the difference between the volatility of the interest rate in both countries has fallen significantly. On the other hand, in Table 5, we see that the volatility of the exchange rate in New Zealand was greater than that in Australia during the second half of 1999 and in 2000, while during most of 1996 and 1997, that of Australia was greater.

In order to study the distribution of the effect caused by fluctuations in the yield of foreign bonds, in the interest rate and in the exchange rate, we analyse the joint behaviour of these three variables for the case of Mexico in the context of the floating exchange rate regime and the BR framework. In this exercise, we estimate a VAR that includes the yield of the external bonds, the logarithmic change in the exchange rate, and the overnight rate during the period from 5 March 1996 to the end of 2000.[13] In the first row of Graph 10, it is possible to see how in Mexico a shock of one standard deviation to the yield of the external bond causes a statistically significant increase in the interest rate as well as in the exchange rate. In addition, we see evidence of a positive and significant effect of exchange rate depreciation on the interest rate.
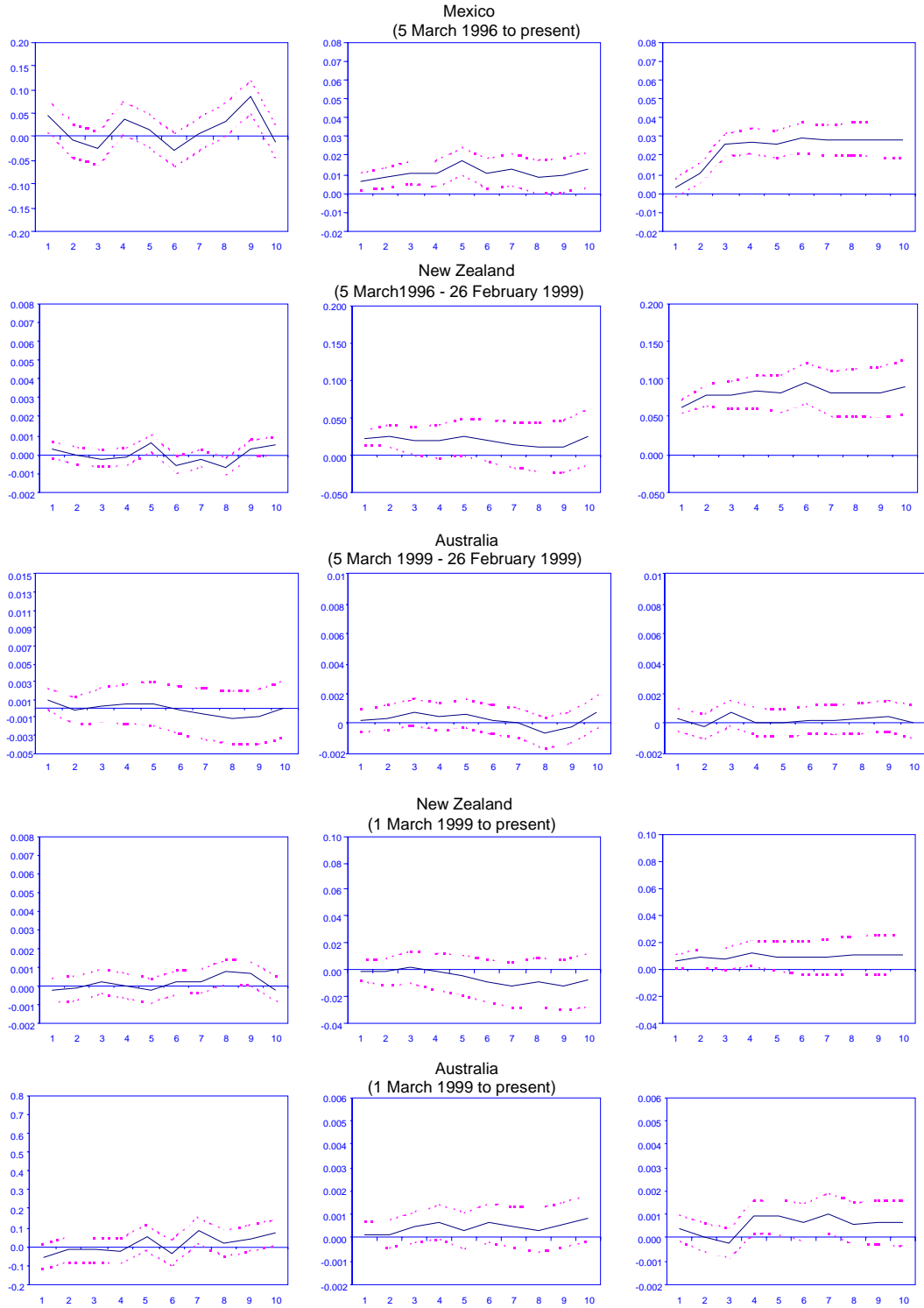
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[13] The observations are daily, the exogeneity order of the variables adopted is: external yield, exchange rate depreciation, interest rate. The number of lags does not change the result.

Graph 10

Impulse response functions

Response of exchange rate to a shock in ext bond gross yield	Response of interest rate to a shock in ext bond gross yield	Response of interest rate to a shock in the exchange rate

Mexico
(5 March 1996 to present)

New Zealand
(5 March1996 - 26 February 1999)

Australia
(5 March 1999 - 26 February 1999)

New Zealand
(1 March 1999 to present)

Australia
(1 March 1999 to present)

These effects can be caused by two factors. First, when the exchange rate depreciates, an increase in expected inflation is observed, causing an increase in nominal interest rate. Second, in the context of an instrument of monetary policy that affects market conditions through quantitative restrictions, the effects can be interpreted as the reaction of the central bank to a depreciation. Under these circumstances, the authority anticipates the inflationary effect by restricting monetary policy.

To analyse the distribution of a shock to the external yield between the interest rate and the exchange rate, we performed a similar exercise for New Zealand during the settlement balances regime in place from 5 March 1996 to 26 February 1999. The second row of Graph 10 shows the same type of reactions. A shock of one standard deviation in the external yield of the New Zealand bond causes a marginally significant and lagged increase in the exchange rate depreciation and a positive and significant transitory effect on the short-term interest rate. Moreover, the increase in the exchange rate depreciation seems to generate significant increases in the interest rate. When the exercise is performed for Australia during the same period (third row of Graph 10), we see that none of these effects is significant.

Next, we analyse the behaviour of the same variables for the period 1 March 1999 to 26 July 2000 (period after the adoption of the interest rate regime in New Zealand). The fourth row of the graph shows that after the change of regime, the interest rate no longer responds to the external shock, and barely responds to the exchange rate depreciation. Finally, in the last row it can be seen that in Australia during this period, only the response of the interest rate to the exchange rate depreciation is marginally significant after some lags.

In this section, we have shown how the implementation of monetary policy imposes conditions on the effect of the external rate on the interest rate and the exchange rate. In the next section, we will address the importance of limiting fluctuations in the exchange rate when these fluctuations have lasting effects on the growth of prices, either directly or through changes in inflation expectations.

3.3 The effect of exchange rate movements on prices

The high pass-through that exists in Mexico can be illustrated in a simple way by comparing the speed of response of prices to changes in the exchange rate for Mexico and for other countries. Graph 11 shows that the long-run effect of an exchange rate depreciation of 10% on prices is greater in Mexico than in Australia.[14] It can also be seen that in Mexico 50% of the effect happens after two quarters, and 82% during the first year. This contrasts with the estimated response in Australia, where in two quarters we see only 7% of the effect, and during the first year the total effect is barely 14%.
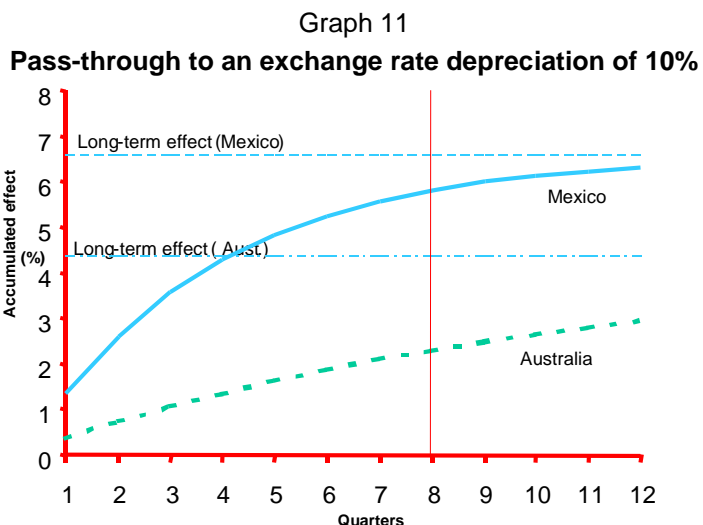
The fluctuations in the exchange rate affect the price index directly through their effect on the prices of tradable goods, or indirectly through changes in inflation expectations, which determine wage adjustments as well as the changes of other prices in the economy. As mentioned above, the importance of the first channel is determined by the degree of openness of the economy, as well as the market structure of the tradables sector.[15] The second channel is affected by the response of inflation expectations to exchange rate changes.

There are several reasons why the effect of exchange rate changes on prices has been greater in Mexico than in other economies. The first is the integration of the economy through trade, which increases the sensitivity of prices, production processes and aggregate demand to fluctuations in the exchange rate. In Mexico, the proportion of total trade to GDP has increased from 15% in 1990 to 58% in 1999, while in Australia this number increased from 26% to 31% during the same period. In addition, the history of high inflation and balance of payments crises followed by surprise devaluations

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[14] The estimation for Australia is taken from De Brower and Ericsson (1998). Garcés (1999) performs this same analysis for Mexico. In addition, he finds that in the Mexican case the response of the price index depends on the amount of the depreciation. In other words, when the depreciation is greater than some limit the reaction of prices is 1 to 1 in the long term, ie the pass-through is complete, and in the case of smaller depreciations the estimated coefficient is less than one.

[15] The response of tradable goods prices to changes in the exchange rate is determined by the market structure of these goods. This structure affects the willingness of participants to use the change in relative prices caused by the exchange rate depreciation to maintain or increase their market share by cutting their profit margins. The importance of these factors for the Mexican economy is studied by Conesa (1998).

contributed to exacerbate the association of inflation expectations with movements in the exchange rate. Graph 12 shows how the exchange rate depreciation precedes the inflation rate, and that there is a very high correlation between the two variables.

Graph 11

Pass-through to an exchange rate depreciation of 10%

Graph 12

**Exchange rate depreciation and inflation rate in Mexico**
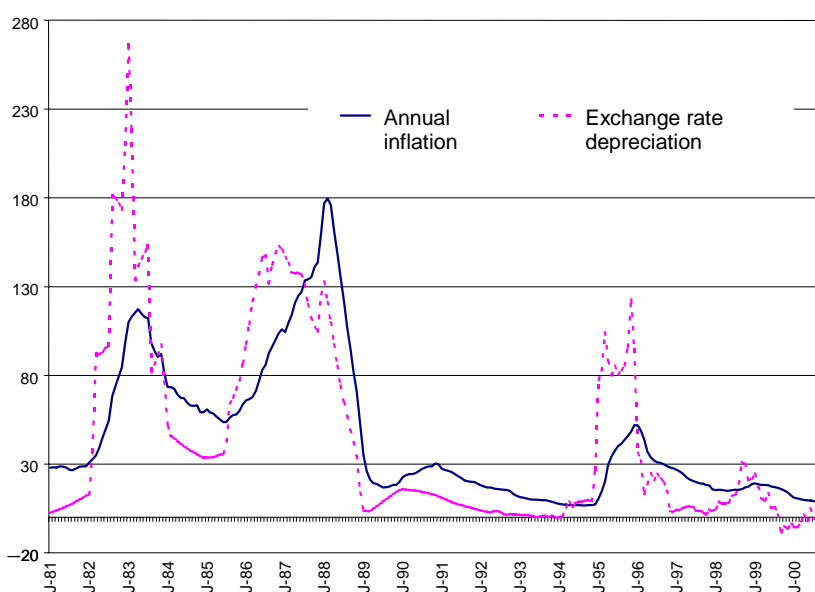
In order to evaluate the effect of exchange rate fluctuations on expected inflation, and to test if it has decreased recently, we estimate a linear regression for expected inflation for the next 12 months as a function of the observed weekly depreciation, the change in the BR objective and inflationary surprises (the gap between observed and expected inflation). The results of this equation are shown in Table 7, where all the coefficients are significant and have the right sign. Next, we perform recursive estimations for the period December 1997 to October 2000. Graph 13 shows the results of this recursive regression for the coefficient associated with the exchange rate depreciation.

Table 7

Determinants of changes in inflation expectations for the next 12 months

	Coefficient	t-statistic
Changes in corto	0.0076 (0.0039)	1.9295
Exchange rate depreciation (– 1)	0.0530 0.0145	3.6618
Inflation surprises	1.0359 (0.2735)	3.7880
Prices of public goods	0.0053 (0.0031)	1.7354
R-squared	0.3259	
F	7.4123	

As can be seen from Graph 13, since 1999 the effect of a 1% depreciation on the changes in inflation expectations for the next 12 months has fallen from around 6 basis points to less than 1 basis point. This could indicate that the pass-through has been reduced. Nevertheless, it is important to note that if a non-linear relationship exists between the exchange rate depreciation and the inflation rate, our results would be biased. So the recent fall in the pass-through[16] would be at least partially explained by the fact that lately there have been no abrupt movements in the exchange rate.

Graph 13

**Behavior of exchange rate depreciation
coefficient of the previous week**

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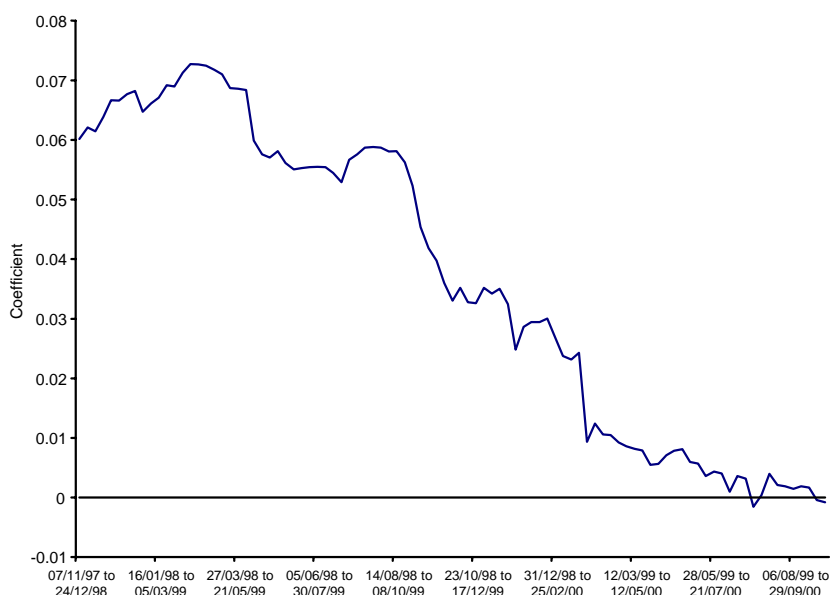
[16] Garcés (2000) finds evidence of a non-linear relationship between the fluctuations in the exchange rate and the inflation rate for Mexico.

3.4   Results of the implementation of monetary policy in Mexico

In the context of the conduct of monetary policy in Mexico, the achievement of the inflation target is the fundamental goal of the monetary authority. In this respect, the central bank acts whenever it considers that the monetary conditions determined by the market are inconsistent with this goal. As we saw previously, in an environment of constant internal and external shocks the current implementation of monetary policy in Mexico has been effective in distributing the effect of these shocks between the exchange rate and the interest rate. Nevertheless, under this scheme, the behaviour of the interest rate is also influenced by the actions of other market participants. This implies that monetary policy actions could in principle be offset, reducing their effectiveness in meeting the inflation target.

One way to evaluate the effectiveness of the framework of borrowed reserves and the actions of monetary policy is by estimating the effect on the real interest rate of the typical variables that should enter into the authorities' reaction function. Having done that, we could evaluate if monetary policy has reacted effectively to them. Several authors have studied the policy rule that must be followed in the context of emerging market economies, generalising the analysis of the reaction function of a central bank that determines the interest rate in a closed economy and that has the stabilisation of the price level as its main objective. For example, Svensson (1998) and Ball (1999) develop models of an open economy under rational expectations, and find that the reaction function of the central bank must include the external interest rate and the real exchange rate, in addition to the traditional elements, ie the output gap and the actual or observed inflation rate. At the same time, Corbo (1999) studies the factors that contribute to explaining the conduct of monetary policy in Latin America.

In order to evaluate whether the borrowed reserves scheme used in Mexico has resulted in a behaviour of the real interest rate consistent with the objective of reducing inflation, following the estimations made by Ortiz (2000) we run a function for the behaviour of the ex ante real interest rate, that is, a Taylor rule for the Mexican economy for the period from May 1997 to August 2000. The determinants of the ex ante real interest rate that are included in the analysis are: the deviation of private sector inflation expectations from the central bank's target, the measure of the output gap, the depreciation of the exchange rate in the previous period, and the gross yield of public sector debt denominated in foreign currency.

The results under different specifications are shown in Table 8. In the first three columns, the real rate was calculated based on expected inflation for the next 12 months. For the last three columns, expected inflation for the month was taken; it is clear that in this case we will have important seasonal fluctuations and the estimated real rate was therefore adjusted to eliminate that variability.

Column (1) shows the results obtained for the period mentioned. All the coefficients have the expected signs, even though the output gap is not statistically significant. The results in column (4) also correspond to the full sample using the second estimation described for the interest rate. In this case the signs are also as expected, but only the external rate is significant.

During the period from May 1997 to November 1998, international financial markets suffered shocks caused by the Asian and Russian crises. These events were a source of high volatility for emerging market economies, and translated into increases on the yield of bonds placed in the external markets and in considerable exchange depreciations. In addition, as explained in Section 2, in 1998 Mexico started its transition to a new framework of explicit inflation targets. In order to capture a possible change in the determinants of the ex ante real interest rate during this period, caused by external factors as well as by changes in the reaction function of the monetary authority, the sample was divided in two. The results for the first subperiod are shown in columns (2) and (5). As can be seen from these columns, the only significant determinants of the real ex ante interest rate for the period from May 1997 to November 1998 turn out to be the yield of the bonds placed in the external markets and the exchange rate depreciation of the previous period.

On the other hand, for the period from December 1998 to August 2000, when a greater stability in international financial markets was observed, the relative importance of the determinants of movements in the real interest rate is reversed. As can be seen from the results shown in colums (3) and (6) of Table 8, the coefficient of the deviation of expected inflation from target inflation increases and becomes statistically significant, as does the coefficient of the output gap. The coefficients of the yield of bonds placed in the external market and of the exchange rate depreciation, on the other hand, become non-significant.

From these results we can conclude that during the period of greater stability in the international markets and transition towards an inflation targeting regime, the behaviour of real interest rates was consistent with the necessity to eliminate the inflationary pressures coming from the internal market.

Table 8
Monetary policy rule of the Bank of Mexico

	Real interest rate (12-month inflation expectations)			Real interest rate (one-month inflation expectations)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	-10.92 (-8.28)	-16.12 (-15.06)	-6.92 (-7.65)	-16.94[1] (-9.34)	-30.52[2] (-13.16)	-4.24 (-6.22)
Expected inflation - inf target	1.65[3] (-0.49)	0.72 (-0.89)	2.80[3] (-0.78)	0.45 (-0.47)	-0.59 (-0.76)	1.21[2] (-0.52)
Output gap	0.09 (-0.18)	-0.22 (-0.31)	0.42[2] (-0.17)	0.04 (-0.23)	-0.48 (-1.24)	0.34[1] (-0.17)
Lagged depreciation rate	0.39[3] (-0.16)	0.61[3] (-0.21)	0.08 (-0.20)	0.17 (-0.15)	0.36[1] (-0.19)	-0.22 (-0.25)
Yield of the government bonds placed outside	1.51[2] (-0.87)	2.13 (-1.60)	0.97 (-0.83)	2.14[2] (-0.99)	3.62[2] (-1.43)	0.79 (-0.67)
N	41	19	22	41	19	22
$\overline{R}^2$	0.63	0.68	0.68	0.44	0.64	0.36

Note: Standard errors are in parentheses.
[1] Significant at 10%. [2] Significant at 5%. [3] Significant at 1%.

The analysis presented in this section indicates that the implementation of monetary policy in Mexico based on the use of a borrowed reserves target and the application of the corto has implied a behaviour of real interest rates consistent with the stabilisation of the price level. In a context of high external volatility and high pass-through, the implementation of monetary policy has contributed to absorbing shocks without causing constant reversions in the instrument of monetary policy, which would have sent ambiguous signals to market participants. On the other hand, in the recent period of greater stability, the monetary framework has resulted in an interest rate behaviour focused on offsetting shocks to aggregate demand and to the spread between inflation expectations and the inflation target. In the following section, we continue the analysis of the effectiveness of monetary policy through the study of monetary policy transmission channels.

4. The transmission channels of monetary policy in Mexico: 1997-2000

4.1 Description of the transmission mechanism

The economic literature has widely reviewed the process by which the monetary authority can influence the inflation rate, both from a theoretical perspective and from an empirical one. Diagram 1 illustrates the mechanisms, developed in this literature and summarised by Mishkin (1995), through which the monetary authority affects the evolution of the inflation rate. The authority, through its monetary policy actions, has the power to influence short-term interest rates and future expected inflation. The central bank can affect the interest rate directly, as most central banks do at present, or indirectly through quantitative restrictions such as the one used by the Bank of Mexico. The differences, advantages and disadvantages of the instruments used by some monetary authorities were presented in Section 3.1.

As can be seen from the diagram, the interest rate affects the evolution of expected inflation, which can also influence actual inflation, reinforcing the effect of the actions taken by the central bank. Below, we explain how these variables affect aggregate demand and other economic variables that

influence the determination of prices. For simplicity, we describe the transmission of a restrictive monetary policy. The mechanism operates the other way around with an expansionary policy.

Diagram 1

Monetary policy action
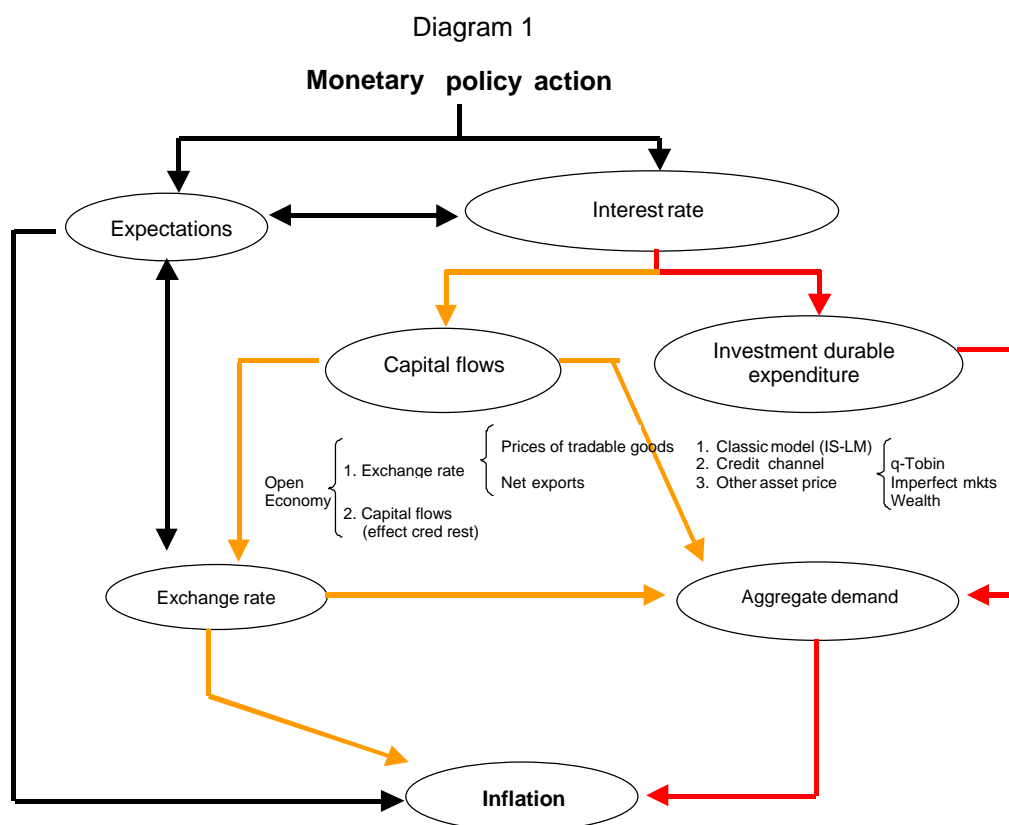
When the announcements of the authority have perfect credibility, the central bank can control inflation without needing to significantly affect economic activity. This happens because if all the economic agents believe in the target and make their pricing decisions based on this, the growth of prices will be equal to the inflation target. In this scenario, there will never be disparities between expected and targeted inflation, and therefore action by the authority to induce a price behaviour consistent with the targets will not be needed. In these circumstances, a reduction or direct control of the inflation rate can be achieved at minimum cost. This phenomenon depends to a great extent on the reputation that the authority enjoys. However, in general, an economy with high inflation that requires a stabilisation process finds it hard to achieve the necessary credibility.[17] In these cases, in the absence of a restrictive policy expected inflation will remain above the authority's inflation target. Therefore, to reach the target it will be necessary to induce a deceleration of the economy through an increase in the interest rate.

The increase in the real interest rate affects inflation in two ways. The first effect arises through the impact on the financing cost, which can be divided into three channels. The first of these is the aggregate demand channel. This channel is the one illustrated in the traditional IS-LM model and indicates that an increase in the short-term interest rate is transmitted to the whole yield curve, increasing the price of financing and thereby inducing a reduction in investment and an increase in savings. This reduction in aggregate demand reduces the pressure on prices and eventually on inflation. The second channel is the so-called credit channel, first highlighted by Bernanke (1983). This channel arises as a result of imperfections in the credit market. Through its effect, an interest rate increase will be translated into a reduction in the supply of credit. In the literature, different reasons for

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[17] Except for the model presented by Sargent (1986), most of the stabilisation models require a cost in terms of output and employment to succeed.

how this effect is produced have been presented.[18] Moreover, it has been separated into the banking credit channel and that of the broader definition of financial sector, which has been called the financial accelerator mechanism. The banking credit channel can be explained in the following way. An increase in the lending rate attracts riskier projects, increasing banks' monitoring cost and causing an increase in the intermediation cost, which is reflected in the spread between the lending and deposit rates. This has consequences, in the last instance for the supply of credit, affecting investment negatively. Because of this, to verify the existence of that channel several authors have empirically studied whether monetary policy affects this spread. Other studies have analysed the effect of this spread on investment after controlling for the interest rate. A similar effect, the accelerator, is triggered as a result of a recession. When the wealth of the agents drops, agency problems increase and credit supply should fall and the interest rate spread increase (Bernanke and Gertler (1989)).

The third channel related to the financing cost arises as a result of a reduction in asset prices motivated by the increase in the interest rate. According to Tobin's *q* theory of investment, when the value of a company, approximated by its market value, is less than the cost of capital there should be a decrease in its assets or negative investment. The presence of asymmetric information in financial markets reinforces this effect, because in these circumstances a company access to financing depends to a great extent on the collateral it can offer. This is determined by the value of the company, which for public companies is given by its market value. For that reason, when interest rates are increased, stock prices fall and with it the companies capacity to find financing; resulting in smaller investment. In addition, the fall in the stock market implies a reduction in the wealth of the individuals that invest in this market, who will reduce their consumption as a result of this shock.

The second way in which the real interest rate affects inflation, denominated the *exchange rate channel*, only applies in an economy open both to trade and to capital flows. When there is an increase in interest rates, investment in peso-denominated bonds becomes more attractive, and an increase in the flow of capital towards the country is generated. Under a flexible exchange rate regime, this flow results in an appreciation of the exchange rate. In a country like Mexico, with little influence in the international markets, the appreciation should be translated into a reduction in the national currency price of tradable goods. This fall in the price of tradable goods makes the production of non-tradable goods more attractive, and a reallocation of resources from the tradable sectors towards the non-tradable ones occurs. From the demand side, when non-tradable goods become relatively more expensive, the quantity demanded will fall. Both effects, demand and supply, lead to an eventual reduction in the prices of non-tradable goods. It should be mentioned that the use of imported inputs can reinforce this effect.

In addition, the impact of capital flows can affect aggregate demand, due to the existence of liquidity constraints for both consumers and companies. This effect works in the opposite direction to the ones described in the previous paragraph. An increase in capital inflows causes the exchange rate to appreciate but also increases aggregate demand. The pressure on prices that results will only be reflected in the non-tradable sector due to the restriction that international competition imposes on the prices of the tradable sectors.

In the following section, we will analyse the importance of the different transmission channels of monetary policy for the Mexican economy. The identification of the relative importance of these is crucial for the evaluation of the effectiveness of monetary policy.

4.2   Estimation of the transmission channels for the Mexican economy

In this section, we empirically analyse the mechanisms by which the transmission of monetary policy to the inflation rate has occurred in the Mexican economy from 1997 to 2000 using VARs.

We present a simple model that incorporates the elements described in the previous section that are relevant for an open economy and that we will be using to determine the limitations of the identification assumptions imposed when estimating the VAR. The first equation is given by an accelerating Phillips curve which relates the change in the observed rate of inflation to the output gap and the devaluation

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[18]   The first formalisation of this channel was performed by Bernanke and Blinder (1988), in which required banking reserves had a crucial role.

of the real exchange rate (this is the nominal depreciation minus the inflation rate). In order to maintain a limited number of variables in the system, without excluding fundamental variables of the transmission mechanism of monetary policy, we use the core inflation rate. In this way, we avoid the problem of trying to control for variations in inflation associated with additional shocks, such as those that affect the determination of prices of public goods, of agricultural products and of commodities that are determined in international markets. It is clear that even so, the fluctuations in the prices of goods and services not included in the calculation of core inflation can have an effect indirectly and with a certain lag.

$$\Delta \pi_t = \alpha_0 + \alpha_1 (y - y_p)_t + \alpha_2 \Delta RER_t + \varepsilon_t^{\pi} \tag{1}$$

Equation (2) shows the determinants of the output gap. This gap depends, in the first instance, on the real interest rate and on the real exchange rate. The effect of these variables appears with at least one lag, although in general it has been found in the literature that this lag is longer than six months. The error in this equation could be interpreted as shocks to fiscal policy, or to the marginal propensity to consume due to variations in the expectations of future economic growth.

$$(y - y_p)_t = \beta_0 + \beta_1 r_{t-i} + \beta_2 RER_{t-i} + \varepsilon_t^{y} \tag{2}$$

Although monetary policy in Mexico has not been implemented through the direct setting of interest rates, we can say that independently of the instrument used by the central bank, any change in the real interest rate affects the evolution of the determinants of inflation and, eventually, in the behaviour of inflation. Equation (3) describes the real interest rate determination process, which can be interpreted as the reaction function of the market and the central bank, and which is similar to the one presented in Section 3. To avoid making unnecessary assumptions, the output gap is incorporated contemporaneously, which assumes that the monetary authority counts on reliable forward-looking indicators. By adopting this specification, it is possible to determine if this reaction occurs contemporaneously or with a certain lag.

$$r_t = \gamma_0 + \gamma_1 (y - y_p)_t + \gamma_2 (E(\pi) - \pi_{obj}) + \gamma_3 (\Delta RER_t) + \varepsilon_t^{r} \tag{3}$$

It is important to note that the relevant interest rate in equations (2) and (3) is the ex ante real rate, since the monetary authority as well as investors and consumers make their decisions based on this rate. This happens because the actual rate of inflation is only observed with a certain lag. To complete the model, we only require an equation for the exchange rate, which we can model on the basis of the interest parity condition expressed in real terms. So the real devaluation, in the context of a floating exchange rate, is determined by the disparity of real rates, adjusted by country risk.

An approximation of this model can be estimated with a VAR, adopting a triangular decomposition following the order: RER_t, $(y-y_p)$, π and r. In this specification, we are not considering the effect of the gap between expected inflation and the target. This assumption implies that the error identified as ε_t^{r} will incorporate any exogenous change of the interest rate that is motivated by a change in this difference. Another important assumption is that the interest rate is restricted to affect the RER only with a one-month lag. Finally, the yield of the Mexican bonds denominated in foreign currency is included as an exogenous variable to control for external shocks.[19]

The variables used in the analysis are:[20]

$LRER = le + lp * -lp$	Logarithm of the real exchange rate
$(y - y_p)$	Industrial production index minus its trend[21]
π	Annual monthly core inflation rate (%)

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[19] If the output growth of the United States is included as an additional exogenous variable, the results are not affected.

[20] Because the RER, inflation and the real interest rate are I(1), we tested for cointegration, finding that according to the Johansen test the hypothesis of non-cointegration at 5% is rejected. In addition, the hypothesis that only one cointegration vector exists is not rejected.

[21] The trend was calculated with the Hodrick-Prescott filter.

$r = cetes28 - E(\pi)$ Annual real ex ante interest rate (%)

$i *$ Gross yield of the UMS26 bond (%)

The availability of expected inflation data limits in an important way the period for which the estimation can be carried out, in this case May 1997 to May 2000. Nevertheless, the advantage gained in the explanatory power of the system justifies using this variable for the calculation of the real rate. This happens because during the last few years there have been periods in which expected inflation has shown a high error of prediction and, most importantly, this error has followed an erratic pattern, leading to a significant difference between the results obtained with the real ex post rate and the ones obtained when including an ex ante rate.

The specification adopted and the use of the real ex ante interest rate allow us to identify the shocks to the interest rate independent of other factors that affect the external supply of funds. This is because if we opt for a specification in which the interest rate precedes the exchange rate, even after controlling for the external interest rate, the change in interest rates and exchange rates occurs in the same direction. This reaction represents the response to a shock in the supply of capital flows and not to a change in the interest rate when this supply remains constant.[22]

Graph 14 shows the impulse response functions that result from the estimation of the VAR and the assumptions mentioned above. The rows show the reaction of each of the endogenous variables to each of the structural shocks presented in the columns.

Graph 14

Impulse response functions
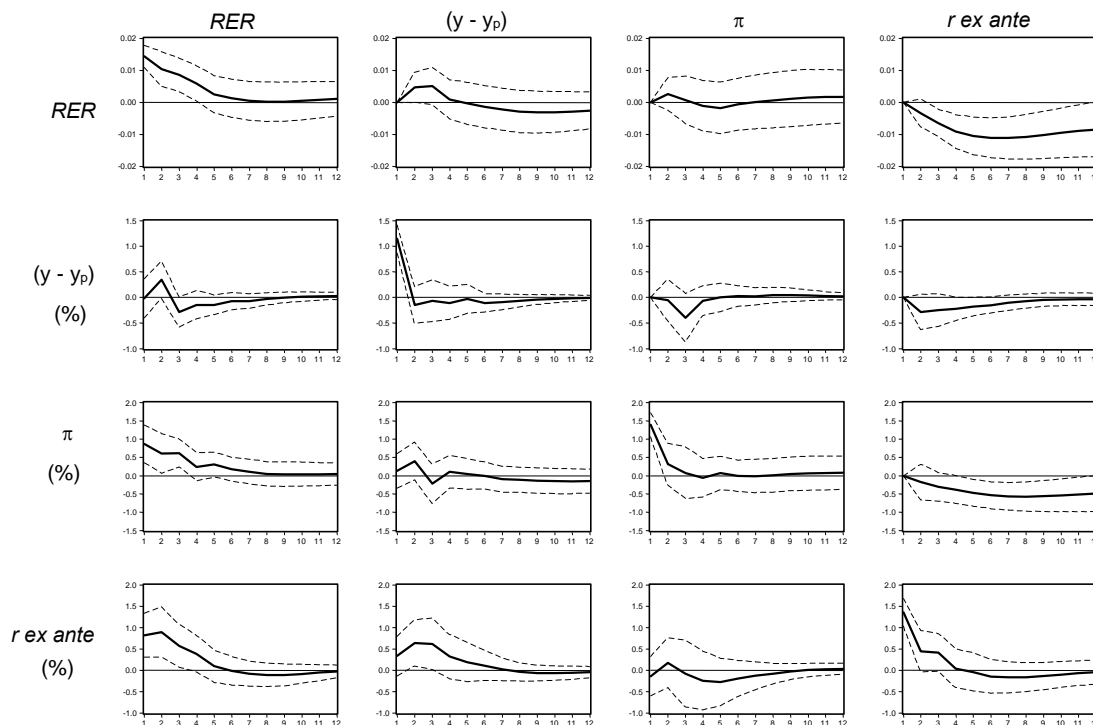
The first column of Graph 14 illustrates the dynamics of the variables as a result of a one standard deviation disturbance to the real exchange rate, equivalent to a real devaluation of 1.4%. This shock can be due to any internal or external factor other than the yield of the bond denominated in dollars, which was incorporated in the estimation as an exogenous variable. The reaction of all the variables is consistent with the expected behaviour. The output gap increases with a one-month lag and after

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[22] Schwartz and Torres (2000) find similar effects when considering innovations to the corto.

three months the effect disappears. The rate of inflation and the interest rate increase instantaneously. Finally, the real interest rate increases by 0.82 percentage points in response to the real depreciation of 1.4%.

In terms of the speed and magnitude of the adjustment of prices to changes in the exchange rate, we found that this adjustment is slower and of smaller magnitude than that obtained in Section 3.3 and to that obtained by other authors (for example Garcés (1999)). This difference is due mainly to the period considered and, as Garcés mentions, there is some evidence that the pass-through from exchange rate movements to prices has decreased in recent years.

The second column corresponds to a shock in the output gap, which could be associated, for example, with an expansionary fiscal policy. In response to an increase in this gap, the RER, inflation and the real interest rate increase. The increase in the real interest rate can be due on the one hand, to the increase in the demand for credit and, on the other hand, to a greater tightening of monetary policy oriented towards reducing the inflationary effect of the expansion.

In the third column we can see the effects of a shock to the rate of inflation, by which the rest of the variables are not affected significantly. In the following section, when discussing the monetary rule we will go deeper into the possible interpretations of the absence of adjustment of the interest rate.

The fourth column presents the reaction to an increase in the real interest rate not explained by a change in some other variable. Since the central purpose of this section is to analyse the transmission mechanism of monetary policy, we pay special attention to the analysis of the results illustrated in this column.

An increase of 1.4 percentage points in the ex ante real rate entails a real appreciation that reaches a maximum of 1% after seven months and then disappears slowly. The output gap also experiences a fall after a month, in this case of 0.3%. This effect is significant between the fourth and sixth month after the shock takes place. The rate of annual inflation also drops, due to the effect of the appreciation as well as the fall in output. This reduction is largest during the eighth month and is equivalent to 0.57 percentage points. It is significant after four months and remains so until the 10th month.

The last row of the graph gives us information about the reaction of real interest rates to different disturbances. These results indicate that the monetary authority and/or the market induce an interest rate increase when inflationary pressures appear as a result of a devaluation (first column) or of an increase in the output gap caused by an increase in the marginal propensity to consume or a loosening of fiscal policy or other demand factor (second column). Nevertheless, in the third column, it is not possible to detect a significant effect on the interest rate of an inflation shock originating from another source of uncertainty. The joint path of these variables could indicate that the market and the authority identify these shocks as transitory or probably seasonal, which is why it turns out to be optimal to keep the real interest rate constant.

Table 9 presents the long-term variance decomposition, ie the variation attributed to each of the shocks as a percentage of the total variance explained by the model. It is important to clarify that because the yield of the bond denominated in dollars was included as an exogenous variable, the explained variance is net of the effect of this variable. The shaded area is of greater interest in the sense that it reflects the relative impact of the independent movements in real interest rates on the evolution of the other variables of the system.

Among the domestic sources of variations in the rate of inflation, the real exchange rate and the output gap, the movements in the real interest rate stand out in terms of importance: they explain 14% of the variation of the output gap and 50% of that of the rate of inflation.

Table 9

Variance decomposition

percentage variance attributable to shocks to:

	LRER	*(y-y_p)*	Infl	*r*
LRER	21	6	2	71
(y-y_p)	12	66	8	14
Infl	20	6	24	50
r	35	19	5	41

Using the estimated coefficients, we can determine how interest rates have deviated from the estimated rule by analysing the path followed by the error identified as a shock to the interest rate (Graph 15). By construction, the average of the error is equal to zero, but it should be noted that during the last year, unlike the rest of the period, this error has been consistently positive. The behaviour of this error indicates that during this period the real interest rate has been on average 1 percentage point above the value determined by the estimated rule. This result reflects the strengthening of monetary policy to continue with greater reductions in the inflation rate. It is important to emphasise that this behaviour could possibly be incorporated in the monetary policy rule, making it more general by including the gap between the expected inflation and the inflation target, so that this bias towards a more restrictive position responds to an increase in this gap. In Section 3.4, structural estimations of the reaction function of the Bank of Mexico were carried out, and indeed we find that this gap is important for the monetary rule and that it has grown in importance in the last year. In this case, the behaviour of the error indicates that for the period mentioned, the interest rate has been only 0.6 percentage points above the value predicted by the rule.

Graph 15

**Deviation of the ex ante real interest rate from
the estimated monetary policy rule**

(percentages)
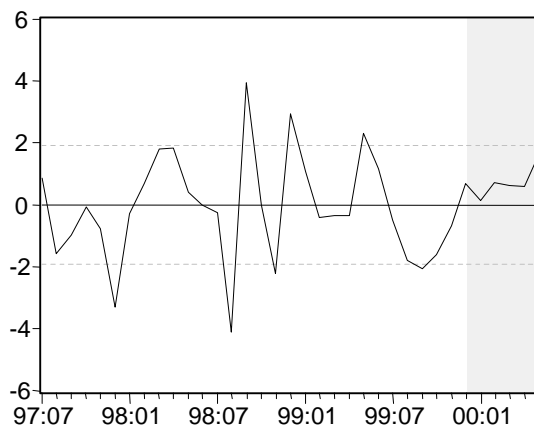
4.3   Decomposition of the impact of a disturbance in the real interest rate

The estimation performed indicates that an increase in the real interest rate causes a real exchange rate appreciation, induces a fall in the output gap and generates a reduction in inflation. Nevertheless, this estimation does not allow us to determine if the fall in inflation is due exclusively to the appreciation of the real exchange rate or if the reduction in the output gap helps to explain this phenomenon. With this objective, a second estimation was carried out, separating tradable goods and

non-tradables. By means of this separation, we want to determine if the fall in inflation as a result of an increase in the interest rate is due purely to the effect of the appreciation on tradable goods prices.

In addition, when describing the channels by which monetary policy affects the economy, we mentioned that the increase of capital flows caused by an increase in interest rates could relax certain liquidity constraints, creating a positive effect on aggregate demand. With the estimation using aggregate economic activity performed in the previous section, we can not determine if this effect exists. However, we find that, where it is present, it is offset by the recessionary impact of the interest rate. If we now analyse the inflation in non-tradable goods separately, we can determine if the increase in the demand for this kind of good caused by this effect is superior to the recessionary effect. In this way, we can see whether a restrictive policy causes a reduction in prices, not only through its impact on the nominal exchange rate but also through its negative impact on aggregate demand.

In this exercise, for tradable goods inflation we used the inflation from the core price index for merchandise, and for non-tradable goods we took the core price index for services. Unfortunately, for the non-tradable sector there are no reliable monthly indicators for the output gap. Due to this limitation, the sectoral output gap was not included in the estimations. In order to be able to compare the results, this variable was also excluded for tradable goods.

A VAR for each sector was estimated, similar to the one presented in the previous section, including the following variables: *LTCR, π_i and r,* in that order and with *i=trad or nontrad*, according to the case. Because the identification methodology is the same as the one described above, the interpretation of the shocks is also similar.

Graph 16 shows the impulse response functions for the rate of inflation in both sectors to an exchange rate shock.[23] As expected, the effect of the exchange rate on the inflation in tradable goods is immediate. A depreciation of 1% causes an increase in annual inflation of 0.83 percentage points. In the case of non-tradable goods, the effect is very small and non-significant.

Graph 16

Impulse response functions to a shock in *RER*

Tradable goods (merchandises)   Non-tradable goods (services)

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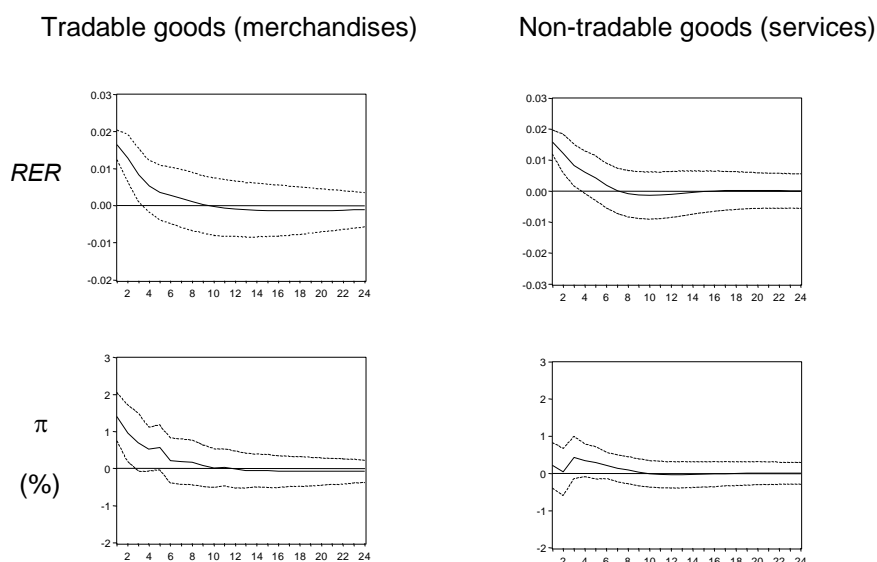
[23] The graph of the impulse on the interest rate is not included to save space and because this is very similar to the one presented in the estimation for the aggregate economy.

Graph 17 shows the impulse response functions of a shock to the real interest rate. In both sectors a fall in the inflation rate occurs, although the effect occurs more quickly and is of greater magnitude in the tradables sector. These results indicate that the increase in demand in response to greater financing is relatively less important compared with the effect of the appreciation and the contraction caused by the direct effect of the interest rate. In addition, according to the functions shown in Graph 16, the exchange rate depreciation has a small and non-significant effect on the inflation in non-tradable goods. The fall in inflation in these goods associated with the increase in the real interest rate is explained by the effect of the contraction of the output gap and not by the exchange rate appreciation.

The variance decomposition for inflation (Table 10) shows that even in the non-tradable goods sector shocks to the real interest rate are very important in the determination of inflation, explaining 44% of the variance for this variable. For tradable goods the importance is lower because in this case the exchange rate plays a fundamental role. Nevertheless, 41% of the variance is generated by the interest rate shock. Moreover, shocks to the real exchange rate explain an almost insignificant percentage of the variance for the inflation in non-tradable goods. These results suggest that the traditional transmission channel of monetary policy has operated in the Mexican economy for the last four years.

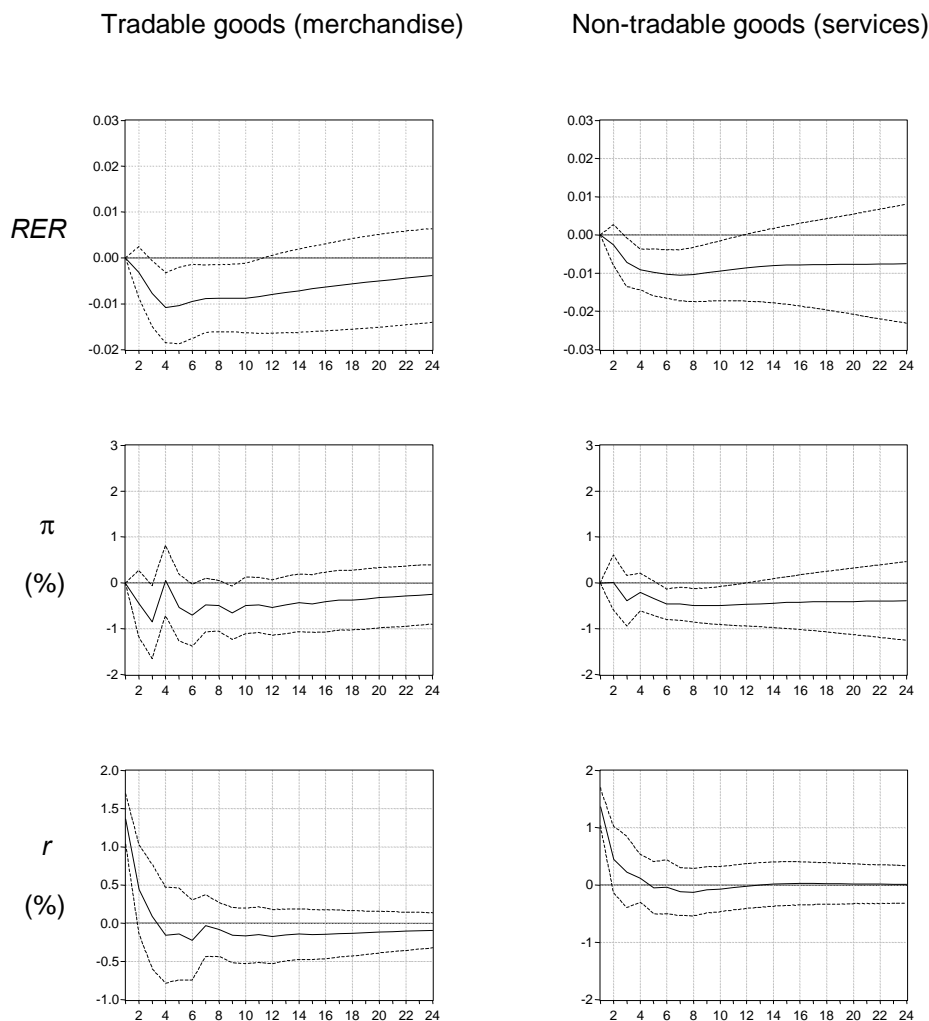## Graph 17

Impulse response functions to a shock in *r*

Tradable goods (merchandise)   Non-tradable goods (services)

Table 10
Variance decomposition
Percentage variance attributable to shocks to:

	RER	Infl	*r*
Tradables infl	34	24	41
Non-tradables infl	6	51	44

4.4 Importance of the credit channel

As described in Section 4.1, imperfections in financial markets tend to amplify the effect of monetary policy. That is, the characteristics of banking credit, unlike commercial paper for example, imply that an increase in interest rates generates a fall in the supply of this type of credit. This contraction in the supply will be reflected not only in a credit contraction but also in an increase in the spread between the lending and deposit rates.[24]

There are some studies that estimate the importance of this channel for the Mexican economy (Copelman and Werner (1995) and Hernández (1999)). Nevertheless, we do not have evidence for the period after the crisis of 1995. This analysis is particularly relevant because since 1995 banking credit has been extremely scarce, which is why a priori it is difficult to think that this channel has been important. On the other hand, it has been found that financing has not occurred through the bond market but through the external market and other non-banking sources, such as supplier credit or trade credit. These alternative credit mechanisms, like banking credit, are subject to serious problems of information, which can give rise to mechanisms similar to the traditional credit channel.

In this section, we empirically analyse this hypothesis, adopting two alternative strategies. The first consists in determining if the interest rate, in reaffirming the monetary policy stance, has had a significant effect on the lending-deposit rate spread and if this has affected economic activity. The second consists in using data on trade loans by companies to estimate the effect that interest rates have had on them.

Monetary policy, interest rates spreads and economic activity

As a first step, an OLS regression was estimated to explain the relationship between interest rates and the spread[25] on interest rates, including as explanatory variables the lag of the spread, the nominal devaluation, the interest rate on Mexican bonds denominated in dollars and the ex ante real interest rate in pesos. The effect of this spread on economic activity was then estimated. This second step is essential due to the limited role that banking credit has played as a financing alternative. This could mean that, even though interest rates have a major effect on spreads, this does not have significant repercussions for the economy. The first column of Table 11 presents the results of the equations for this first step and the last two columns show those for the second step.

When estimating the determinants of the spread (first column), we found that the real rate is positively and extremely significant. In addition, the magnitude of the effect is quite high.

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[24] Kashyap et al (1993) develop a theoretical model with which they derive this result.

[25] The interest rate spread is equal to the lending rate, based on information provided by the firms obtaining credit in Mexico, minus the average funding cost.

Table 11
Effect of the real interest rate on interest rate spreads and on the income gap

	$\left(i^a - i^p\right)$	$(y - y_p)$	$(y - y_p)$
$\left(i^a - i^p\right)$	0.26 (0.19)		
$\left(i^a - i^p\right)_{-4}$			− 0.47[1] (0.23)
r	0.36[2] (0.11)		
r_{-4}		− 0.27[2] (0.08)	0.01 (0.15)
$\Delta\%e_{-4}$	0.13 (0.09)	0.06 (0.10)	0.11 (0.10)
UMS26	0.58 (0.40)		
$\overline{R}^2$	0.84	0.26	0.33
N	37	33	33

Note: Standard errors are in parentheses
[1] Significant at 10%. [2] Significant at 5%. [3] Significant at 1%.

The estimations imply that an increase in the real rate of 1 percentage point is associated with a contemporaneous increase in the spread of 0.36 percentage points and a long-term effect of 0.49 percentage points The second column of the table shows that the real rate is an important determinant of the output gap when we do not control for the spread. This effect is negative and significant, even when controlling for nominal depreciation, and implies that an increase of 1 percentage point in this rate leads to a fall in activity below its potential level, after four months, of 0.27%. Once the spread is included (third column), this variable appears significant and the real interest rate loses its significance. The results indicate that an increase in the spread of 1 percentage point causes, after four months, a fall in the output gap of 0.47%. These results hold even when controlling for different lags of the external interest rate.

Supplier credit and interest rate

For this analysis, we used quarterly data from the non-financial companies quoted on the Mexican stock exchange, for the period 1996 to 1999. The total number of companies considered was 231. The following concepts were used as proxies for financing via suppliers: clients and receivables, which reflect the credit that these companies grant; and supplier credit, which reflects the debts owed to them. Because both concepts reflect a stock, first differences and growth rates were alternatively taken as endogenous variables.[26] In order to control for the economic situation, we included as explanatory variables different transformations of net sales.[27] In addition, the contemporaneous and lagged real interest rates were included as interest variables. The estimations were carried out using a fixed effect model and they appear in the first two columns of Table 12.

The first column of the table shows the results for receivables, where we find a contemporaneous positive effect of the interest rate, and a negative effect when using a one-quarter lag. The initial positive effect, common in this kind of estimation, is due to an increase in the credit default rate. Thus, at the beginning the former effect dominates the fall in new credits, and only after three months does

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[26] For reasons of space and because the results are not significantly modified, Table 12 includes only the results obtained with the growth rates of the endogenous variables.

[27] GDP growth was also used, but because the results were very similar they were not included in Table 12.

the latter effect become more important. The net effect of an increase of 1 percentage point in the rate is a reduction of 0.6 percentage points in the growth rate of the receivables.

Table 12

Effects of interest rates on trade credit

	Receivables	Suppliers	Receivables	Suppliers
	1996-99		**1989-94**	
r	0.01[1]	0.03[2]	-0.14	0.35
	(0.006)	(0.007)	(0.356)	(0.442)
r_{-1}	-0.02[1]	-0.04[2]	0.11	0.12
	(0.006)	(0.007)	(0.331)	(1.796)
Sales	-0.00	-0.00	0.000	0.0004[2]
	(0.000)	(0.000)	(0.000)	(0.000)
N	2,095	2,064	4,445	4,430
$\overline{R}^2$	0.58	0.04	0.30	-0.03

Note: The dependent variables are growth rates. Standard errors are in parentheses

[1] Significant at 10%, significant at 5%. [2] Significant at 1%.

The second column shows the same specification using supplier credit as the endogenous variable. The results also confirm the hypothesis that supplier credit is not immune to changes in the stance of monetary policy. In this case, the net effect of this change in the interest rate is a 1 percentage point in the growth of debts with suppliers.

In the last two columns of the table, we present similar estimations for the pre-crisis period from 1989 to 1994, with the aim of analysing whether supplier credit followed the same pattern even though banking credit experienced strong dynamism. This comparison is important because in the sparse literature that analyses the effect of interest rates, and in particular changes in monetary policy, on supplier credit it is found that supplier credit behaviour is the opposite of banking credit behaviour, which implies that the former is an imperfect substitute for the latter. When finding that this result does not hold for Mexico during the period from 1996 to 1999, the dilemma arises owing to the fact that in general supplier credit is a complement of banking credit or due to the absence of this type of credit during the period analysed. According to the table, the result is very different for the period before the crisis (1989-94). In this case, a significant effect of the interest rate on credit is not found. This reflects the fact that before the crisis supplier credit responded to factors other than the aggregate conditions of the economy, such as cash flow or net sales, that now become significant for the second specification.

Although the evidence confirms that the interest rate has negatively affected the amount of credit in the economy, the conclusion that this effect is completely attributable to the credit channel is questionable. A more detailed analysis, which is beyond the scope of this work, could contribute in an important way to resolving this question. Nevertheless, both strategies indicate that an increase in the interest rate implies a fall in credit even if it occurs directly or as result of a fall in aggregate demand. What matters for our purposes is that ultimately the interest rate channel works independently of the exchange rate in the Mexican economy in spite of the low levels of banking credit.

5.   Conclusions

In this paper, we addressed the implementation of monetary policy in Mexico. We first described the evolution of the monetary policy framework in Mexico since 1995, and then the operating mechanism and the response of the central bank to shocks affecting the exchange rate and its effects on economic activity and, ultimately, the rate of inflation.

The exchange rate and financial crisis that took place at the end of 1994 and during 1995 forced the authorities to adopt a freely floating exchange rate regime. The use of the exchange rate as the nominal anchor of the economy was therefore abandoned. Due to criticisms about the lack of

transparency and dissemination of information, and given the need to establish a visible and strict nominal anchor, in 1995 a target for the annual growth of net internal credit was adopted. In addition, as a consequence of the great uncertainty with respect to the evolution of the Mexican economy, it was considered extremely risky to use a short-term interest rate as the instrument of monetary policy. Therefore, with the aim of implementing an operating framework in which the exchange rate as well as interest rates were freely determined, the Bank of Mexico adopted a borrowed reserves target as its instrument.

Since 1998, monetary policy has undergone a gradual shift towards an explicit inflation targeting framework. In the process, the monetary base has become less important as an intermediate target and the short- and medium-term inflation targets have increased in importance. The implementation of discretionary monetary policy actions has contributed to the attainment of these targets.

The relevance of this study lies in clearing up some doubts about monetary policy in Mexico:

1.   the advisability of using a quantitative restriction as an instrument in an environment in which most countries have adopted interest rates objectives.

2.   the effectiveness of monetary policy, in general terms, in an open economy in which domestic banking credit has been very limited.

With respect to the first point, we found that although the corto entails greater uncertainty over its effect on interest rates, compared with an interest rate objective, it has been very effective in distributing the impact of external shocks between the exchange rate and the interest rate. This advantage is extremely important for the Mexican economy, which is exposed to great volatility and a high pass-through of changes in the exchange rate to prices. The second point above is supported by the finding that this mechanism has contributed in a significant way to the stabilisation process, especially since 1998, when the ex ante real interest rate has reacted significantly to deviations of expected inflation from the target.

With regard to the effectiveness of monetary policy, our results indicate that in addition to the exchange rate channel, monetary policy has affected inflation via the financing cost in the Mexican economy since 1997.

By estimating a VAR, we reached the conclusion that this effect has been particularly important. In the first instance, we found that an exogenous increase in the ex ante real interest rate negatively affects the output gap. An increase of 1 percentage point in this rate leads, after a month, to a fall in GDP of 0.2% with respect to its potential level. This effect is significant between the fourth and sixth months after the initial disturbance.

When analysing the tradable and non-tradable sectors separately, we observed that the exchange rate by itself has not had a significant effect on the price of non-tradable goods, while exogenous increases in interest rates have caused a negative and significant effect in that variable. Both results indicate that the interest rate channel, in addition to its effect through the exchange rate, has negatively affected aggregate demand and, ultimately, the price level.

An additional channel through which monetary policy has operated is credit conditions. Increases in real interest rates have been reflected in higher intermediation costs, measured as the spread between the lending and deposit rates, and these have resulted, in turn in a reduction of the output gap. An increase of 1 percentage point in the ex ante real interest rate causes an average increase in this spread of 0.36 percentage points immediately and 0.49 percentage points in the long term, leading to a fall in the output gap of 0.23% after four months. In addition, we found that an increase in the ex ante real interest rate has negatively affected supplier credit. On average, an increase of 1 percentage point in this rate initially causes an increase but after three months a fall is observed, the net effect being a reduction of 0.6 percentage points in the growth rate of suppliers' credit.

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