The monetary transmission mechanism in Mexico: recent developments

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I. Introduction

Monetary policy actions are transmitted to the economy through several channels. The relative importance of the different channels and how they change through time, along with the lagged effect of these actions on key variables, are crucial for monetary policy decision making. This paper provides an overview of the transformation of the Mexican economy in recent years and analyzes its implications for the inflation process and the monetary transmission mechanism. After a brief review of the macroeconomic policies and financial reforms that have taken place over the past decade, we summarize recent research undertaken at Banco de México that suggests significant changes in inflation dynamics and in some of the channels of monetary policy transmission have taken place in the last years. We also present estimates to illustrate the increasing importance of the credit and expectations channels of monetary policy transmission, using VAR analysis and a small-scale macroeconomic model.

During the last decade, the inflation process and the monetary transmission mechanism in Mexico have undergone important changes. The decade was marked by the recovery from the 1995 financial crisis. Fiscal and monetary policies have been oriented towards the attainment of macroeconomic stability as a necessary condition for sustainable growth. Macroeconomic stability, together with financial reforms and other measures to improve the regulatory and supervisory frameworks of the financial system, have allowed the restoration of credit and the development of deep and liquid financial markets.

The level and volatility of inflation have not only declined in recent years, but also its persistence has decreased notably (Capistrán and Ramos-Francia (2006)). Moreover, evidence suggests that inflation has switched from a non-stationary to a stationary process (Chiquiar, Noriega and Ramos-Francia (2007)).

The adoption of macroeconomic policies conducive to stability (ie fiscal discipline, a floating exchange rate regime, financial sector reforms, and an inflation targeting framework to conduct monetary policy) have improved the functioning of the economy's nominal and real systems, thus, reshaping the channels of monetary transmission. The transmission mechanism of monetary policy indeed seems to have changed (Gaytán and González-García (2006)).

With respect to inflation targeting, there is empirical evidence of the benefits of this policy framework in anchoring inflation expectations (Capistrán and Ramos-Francia (2007)). Inflation targeting has not only implied a change in the policy reaction to different shocks that affect inflation but, as the functioning of the economy's nominal system, and thus that of the real economy, have markedly improved in recent years, it has also contributed to change the

[1] Banco de México. The views and conclusions expressed in this paper are solely those of the authors and do not necessarily reflect those of Banco de México. We would like to thank first Alejandro Gaytan, whose help proved invaluable in this task. We would also like to thank Ana Aguilar, Alejandro Díaz de León and Alberto Torres for helpful comments and suggestions. Finally, Jorge Mejía, Claudia Ramírez and Gabriel Ruíz provided excellent research assistance.

way in which the stance of monetary policy is transmitted to other variables. Regarding the exchange rate, the information content about inflationary pressures derived from changes in this variable has decreased considerably. On the one hand, real exchange rate shocks are now absorbed more by the nominal exchange rate and less by domestic inflation (Gaytán and González-García, op cit). The results presented in this paper show that there has been a significant reduction in the pass-through from the exchange rate to prices and, thus, in the relative importance of the exchange rate channel in recent years.[2]

Two additional channels of monetary transmission are explored in this paper: the credit and the expectations channels. Regarding the effects of monetary policy on lending, the results are still mixed. Firms' financing through securities has recently become more responsive to interest rate fluctuations. Nevertheless, statistical exercises suggest that the interest rate does not seem to have the expected effect on bank credit to households. Possible explanations for this result concern both the demand for and the supply of credit. On the demand side, after several years of tight credit constraints, households in Mexico are rapidly increasing their demand for consumption and mortgage credit, possibly implying a temporary relatively-low sensitivity of demand to the interest rate. On the supply side, the restitution of soundness to the banking system, enhanced credit information and contract enforcement, and a greater availability of financial resources have also complicated the evaluation of the effects of monetary policy on banks' supply of credit. However, as households approach their desired level of indebtedness and the one-off effects of the improvement in financial conditions start to wear off, the traditional interest rate (intertemporal substitution of consumption) and credit channels of monetary policy transmission will tend to strengthen.

Monetary policy has been able to induce a stronger and faster reduction of inflation in recent years. However, the traditional interest rate, exchange rate, and credit channels of monetary policy transmission cannot account completely for this change. The expectations channel of monetary policy has also contributed substantially to this result. Ramos-Francia and Torres (2006) use a New Phillips curve framework to analyze whether in recent years, as the economy has converged to a low inflation environment, the relative importance of the backward- and forward-looking components of inflation in explaining its short-run dynamics has changed. In effect, under the assumptions used in that approach, evidence suggests that the fraction of firms that set their prices using a backward-looking rule of thumb has decreased, and that the forward-looking component of the inflation process has gained importance. This paper extends the analysis on the change in relative importance of these two components by using a rational expectations small-scale macroeconomic model. We find an increasing role of expectations in determining the response of the economy to shocks. The change in the importance of expectations has contributed to allow a faster reduction of inflation at a lower output cost.

The structure of the paper is as follows. Section II presents a review of macroeconomic policy and financial reforms over the last decade. Section III presents a first attempt to intuitively explore the consequences of these policies on the operation of the different channels of the monetary transmission mechanism. Section IV presents statistical evidence of the changes that have taken place in the inflation process and in the transmission mechanism of monetary policy. For this purpose, Section IV.1 summarizes recent research undertaken at Banco de México and introduces new estimations of the nominal exchange rate and the credit channels. Section IV.2 presents evidence of the changes in the expectations channel of monetary transmission. Concluding remarks are made in Section V.

[2] Previous research found a large exchange rate pass-through, even after the adoption of a floating exchange rate, concluding that the exchange rate channel was the main channel of monetary policy transmission.

II. Macroeconomic stabilization and financial reforms

II.1 Fiscal and monetary policies

At the end of the eighties and beginning of the nineties, stabilization efforts were undertaken to end the recurrent financial problems that the Mexican economy had undergone since the 1982 external debt crisis. The main elements of this stabilization program were: a fiscal retrenchment effort, a renegotiation of Mexico's external public debt, negotiations to limit and coordinate price and wage increases, and the use of the exchange rate as the nominal anchor of the economy, through a quasi-fixed exchange rate regime. Initially, the new policy framework was successful, as annual inflation decreased from 159.2 percent in 1987, to 8.0 percent in 1993.

The signing of NAFTA, the liberalization of the capital account, and financial sector changes, such as the privatization of the banking system, the abandonment of forced loans, reserve requirements, and interest rate ceilings, led, in a context of high liquidity in international markets, to large capital inflows. These capital inflows fed a lending boom,[3] which transformed into an expenditure boom and an increasing current account deficit.

Financial liberalization, however, was not accompanied by adequate regulation and supervision of banks. The combination of weak regulatory and supervisory frameworks and ample liquidity in the market generated a credit portfolio of dubious quality and the accumulation of significant currency and maturity mismatches in banks' balance sheets. In addition, as several shocks affected the economy, deteriorating Mexico's macroeconomic situation, the federal government changed the composition of its debt to short-term dollar-denominated securities in an effort to stave off the adjustment that would have otherwise led to a financial crisis.

With the sudden reversal of capital flows at the end of 1994, defending the exchange rate became unsustainable. Mexico was forced to abandon the peg, generating a significant exchange rate adjustment that fed inflationary expectations. As a result, interest rates escalated and economic activity fell sharply. These developments, together with the currency and maturity mismatches of commercial banks' balances and the profile of the government debt, threatened the viability of the financial sector. In order to avoid a systemic run on banks, depositors were backed in full by the federal government. Several programs were put in place to attain this objective: (i) short-term dollar financing to commercial banks; (ii) subordinate debt programs to capitalize banks; (iii) interest rate discounts for debtors on performing loans; (iv) purchases of bank loans at book value if banks brought in additional resources to increase their capital; and (v) intervention of non-viable banks.

On the fiscal front, two immediate measures were implemented after the crisis. First, the government negotiated an international financial assistance package of over 50 billion dollars, to meet the large amount of its short-term dollar-denominated liabilities. Second, to induce an orderly macroeconomic adjustment consistent with the sudden stop of capital flows, fiscal policy was oriented to increase public savings through a rise in indirect taxes and public prices, and a contraction of public expenditures (Ramos-Francia and Torres (2005)). In addition to the necessary reduction in absorption, in the following years fiscal policy had to deliver additional margins to absorb the cost of the programs that were put in place to cope with the banking and financial crisis. Since then, the fiscal balance has remained in equilibrium. The economic deficit has represented, on average, 0.58 percent of GDP and, in 2006, –0.1 percent, as compared to an average of 9.87 percent during the eighties. A broader definition of the fiscal deficit, the public sector borrowing requirements (PSBR),

[3] Bank credit to the private sector reached record high levels, accounting for 34 percent of GDP in December 1994.

which includes the change in contingent liabilities – PIDIREGAS, IPAB, FARAC liabilities, and debtor programs has represented, on average, 3.3 percent of GDP during the last ten years, and 0.87 percent in 2006.[4]

Fiscal discipline has allowed for an important reduction of public debt in recent years. For example, while in the mid-eighties Banco de México's definition of Broad Economic Debt reached levels close to 90 percent of GDP, by December 2006 it accounted for only 18.3 percent of GDP.[5]

Moreover, public debt management has been oriented to improve the amortization schedule and to reduce both financial costs and exchange rate vulnerabilities. Nominal stability, financial integration, and the reduction of the market's perception of risk for investments in Mexico have made possible the development of liquid markets for government bonds of different maturities.[6] These factors have allowed the federal government to rely less on external debt markets and to attain a significant increase in debt maturity and duration, reducing the vulnerability of public finances to changes in interest rates and to exchange rate fluctuations.

With the abandonment of the peg in late 1994, monetary policy had to become the nominal anchor, in an environment of severe financial distress and widespread uncertainty about the central bank's ability to achieve price stability.[7] In this context, after the crisis monetary policy at first established a strict limit on the expansion of net domestic credit and a non-negative international assets accumulation target. The objective was twofold: first, to signal that the central bank would not validate further runs on the currency and, second, that the economy could only remonetize through its external accounts.

After the initial turmoil of the crisis, Banco de México introduced transparent and non-discretionary mechanisms of intervention in the foreign exchange rate market (Ramos-Francia and Torres (2005)). The purpose was to avoid excess volatility and to build up the stock of international reserves, while at the same time to prevent these interventions from affecting the floating exchange rate regime, which could be misinterpreted as signals of changes in the stance of monetary policy.

The general strategy of monetary policy relied on three main elements: to maintain a clear restrictive bias in order to induce sustainable reductions of inflation and inflation expectations; to respond appropriately to inflationary shocks; and to improve its transparency (Ramos-Francia and Torres (2005)).

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[4] These items are not recognized as public debt. However, since they are guaranteed by the government, they represent contingent liabilities. PIDIREGAS are long-term productive infrastructure projects assigned to a third party to make the investment on behalf of the public entities, which in turn pay for the finished projects with the resources generated by the same infrastructure. IPAB is the Mexican deposit insurance corporation. The definition of PSBR includes the service of the net liabilities of this entity that were generated during the 1995 banking crisis. FARAC includes the service of net liabilities of the rescue program of private highways. Until now, the trust has not required fiscal subsidies. Debtor programs are credits that private banks transferred in 1995 to the federal government, on behalf of private debtors which were unable to fulfill their financial obligations with the banking system during the 1995 crisis.

[5] A broader definition of public debt, the Ministry of Finance (SHCP) definition of the Historical Balance of Public Sector Borrowing Requirements (HBPSBR), which includes the aforementioned stock of contingent liabilities (PIDIREGAS, IPAB, debtor programs, and FARAC), available from 1990 to 2007, went from 45.7 percent of GDP in 1990 to 35.9 percent in 2006.

[6] Prior to 1995, the government could not borrow at non-indexed fixed rates using long-term securities. Since 2000, it has been possible to issue government bonds at long maturities and fixed rates. The first issuances of 3-year and 5-year bonds took place in January and May 2000; in July 2001, 10-year government bonds were issued; in October 2003, 20-year bonds were introduced; and, finally, in October 2006, 30-year bonds were auctioned for the first time.

[7] Banco de México gained autonomy in a constitutional reform in December 1993.

By 1998, once the biggest challenges posed by the crisis had been mainly dealt with, Banco de México started to signal a clear bias towards a restrictive monetary policy stance through a negative overdraft target on the cumulative balance of commercial banks' current accounts at the Central Bank (the monetary policy instrument known as the "corto"). In addition, the conduct of monetary policy started a gradual process of convergence towards an inflation targeting framework.

In 1999, Banco de México set a medium-term target for the inflation rate for the first time, ie, its convergence to the levels of those of Mexico's main trading partners by the end of 2003. During 2000, other measures were taken: (i) core inflation was defined; (ii) the communication strategy was strengthened through the publication of Quarterly Inflation Reports; and (iii) an explicit inflation target of 3 percent by the end of 2003 was mentioned for the first time. At the beginning of 2001, inflation targeting was formally adopted. In 2002, an annual inflation rate of 3 percent from 2003 onwards was defined as the long-term inflation target, with a variability interval of plus/minus one percentage point.

Ramos-Francia and Torres (2005) document the policy response to demand and cost-push shocks for the 1998–2003 period. They find that the response of monetary policy was consistent with the inflation targeting framework, as the central bank tightened its policy in response to demand pressures, doing likewise in the case of supply shocks when the latter affected inflation expectations.

Significant progress in abating inflation has been attained as a result of the macroeconomic policies implemented after the 1995 crisis. Annual CPI inflation declined from 52 percent in 1995, to 4.05 percent in 2006.[8, 9]

An important element of the macroeconomic framework has been the floating exchange rate regime. In a context of macroeconomic stability, a floating exchange rate adjusts much faster to different shocks, and real shocks are absorbed by the economy more through nominal exchange rate fluctuations and less through changes in inflation differentials. Of course, a floating exchange rate also reduces the incentives for excessive risk taking and thus for speculative capital inflows.

II.2 Financial policies and reforms

A sound financial system is important not only to foster financial intermediation, but to maintain the effectiveness and credibility of fiscal and monetary policies.

The 1995 crisis uncovered several deficiencies in the regulatory framework of banks. In particular, this framework did not provide proper incentives for the healthy development of

[8] Global conditions have been favorable for emerging economies in recent years, contributing to disinflation, lowering risk spreads, and improving the terms of trade. In developing countries, annual inflation fell from 36.7 percent in the eighties, to 5.1 percent in 2005. Stabilization efforts in Mexico and other countries have clearly benefited from a benign global inflation outlook. Among the microeconomic factors underlying this process, the following deserve mention (Rogoff (2006)): (i) greater competition in goods and services as a result of increasing trade; (ii) increased labor supply worldwide as a result of the greater presence of countries like China and India, which has helped to reduce labor costs and the price of labor-intensive goods and services; and (iii) technological progress, which has fostered productivity growth in several advanced economies. While this benign global environment has probably helped macroeconomic stabilization, sound macroeconomic policies have been fundamental for this outcome. In addition, an environment of ample liquidity and high risk appetite in global markets have allowed for a reduction of emerging markets' risk spreads to record low levels.

[9] More recently, the benign effects of globalization on inflation seem to be wearing off, while the adverse effects through high commodity prices seem to have gained in relative importance. Additionally, the sub-prime housing credits episode in the US could trigger a reverse of favourable conditions in credit markets.

the financial system. Full deposit insurance, poor information disclosure requirements, inadequate risk valuation, and underestimated capital requirements generated perverse incentives for excessive risk taking. Among the main financial reforms undertaken in the last decade, the following should be highlighted:

(i) With the abandonment of the rigid exchange rate regime, immediate measures were implemented to develop the foreign exchange market and thus guarantee the effective functioning of the new regime.

(ii) Prudential regulation and effective supervision of financial intermediaries, among others, have been put in place, to create the right incentives for financial institutions, debtors, and creditors. Within these reforms, the following deserve mention:

  (a) To mitigate moral hazard problems, limits to deposit insurance and to related lending were established, and stricter capital adequacy regulations were adopted.

  (b) Some measures were undertaken to improve information on both borrowers (credit bureaus) and financial intermediaries (disclosure requirements, accounting standards).

  (c) Improved evaluation systems of financial institutions' risk management standards (value-at-risk, stress tests, etc.), and measures to upgrade financial supervision and increase market discipline were implemented.

(iii) A new bankruptcy law was enacted. The crisis unveiled that the existing law was not efficient in enforcing contracts, especially in a situation of systemic risk, because it implied large and costly legal disputes, creating incentives for borrowers to renege on their debts.

(iv) The banking law was amended, eliminating ownership restrictions on foreign individuals, as long as they comply with certain legal requirements. This change allowed a faster capitalization of banks.

(v) The development of financial instruments and markets for risk coverage was encouraged. Banco de México lifted the legal restrictions that limited the use of derivative instruments by commercial banks, and published the guidelines and standards of prudent risk management for financial intermediaries operating in these markets.

(vi) The reform of the pension system (SAR) modified the system from a pay-as-you-go to a defined contribution scheme.[10] This reform improved the long-term sustainability of the pension system and has been of great relevance for the development of the financial sector in Mexico, as it has increased the level of private financial savings to record highs.[11]

[10] The SAR refers to the pension system. The new pension system law (Ley del SAR) was enacted in 1996 and covers only pensions of private sector employees/workers. Federal government, state, county, and public enterprise employees/workers were not subject to the new law. Recently, in March 2007, the federal government pension system law (Ley del ISSSTE) was changed to a defined contribution scheme.

[11] At the end of 2006, SAR savings accounted for 13 percent of GDP and 34 percent of household savings.

III. The channels of monetary policy transmission

The monetary transmission mechanism can be broadly defined as the way in which policy-induced changes in short-term interest rates or the money stock affect economic activity and inflation (Ireland (2006)). Although monetary policy is neutral in the long run, in the short and medium term, it can affect economic activity through several channels. The operation of these channels changes across countries due to differences in openness, financial system development, inflation history, constraints on monetary policy, etc.

This section explores the effects of the macroeconomic policies and financial reforms undertaken over the last decade in light of the different channels of transmission of monetary policy, to provide an intuitive exploration of the operation and possible changes of these channels. A crucial element leading to these changes has been the reduction of inflation and inflation uncertainty. Low and stable inflation provides certainty to financial contracts, reducing the risk premium in interest rates and allowing for longer term contracts (Figure 1). This has lowered borrowing costs for the private and public sectors alike, making it possible to obtain credit at longer maturities, and therefore fostering the development of the domestic financial system. Macroeconomic stabilization and financial reforms have also allowed a continuous increase in financial savings. While in the eighties financial savings in domestic assets (M4) represented, on average, 26.5 percent as a proportion of GDP, in 2006 they represented around 50 percent (Figure 2).

A key issue associated to the monetary transmission mechanism is the extent to which monetary policy is able to induce changes in the complete spectrum of interest rates. In principle, the transmission from a policy-induced change in the short-term interest rate to the entire yield curve is done by the markets, through trading based on investors' expected returns on financial instruments at different maturities. Thus, the effect of monetary policy on the term structure is strongly influenced by the depth and liquidity of security markets.

As a consequence of inflation stabilization and fiscal discipline, in recent years, the government has been able to issue long-term securities at fixed rates, allowing a longer yield curve and, therefore, extending considerably the average maturity and duration of government debt bonds. While in December 1994 the average maturity of government debt was 230 days, by December 2006 it was 1,559 days (Figure 3). Long-term government securities have also served as a benchmark for the development of other private long-term instruments.

Since long-term interest rates reflect risk-adjusted expectations on future short-term rates, when inflation expectations are well anchored, a monetary tightening can be associated with a flattening of the yield curve. In this respect, ongoing research at Banco de México shows that the effects of monetary policy on the term structure of interest rates have changed. In the past, a policy-induced change in the overnight rate seemed to generate parallel movements in the yield curve, possibly because of problems of signal extraction or lack of credibility. Indeed, in a context of uncertainty about inflation, it is more difficult to disentangle movements in the cost of funds from the adjustments in risk premium. However, forthcoming research suggests that, in recent years, there is a flattening of the yield curve after a monetary policy tightening (Cortés et al (2007)).

III.1 The traditional interest rate channel

The traditional interest rate channel works directly through aggregate demand. A policy-induced change in the interest rate is transmitted to the entire yield curve and, in the presence of nominal rigidities, leads to a change in real interest rates. Consequently, the cost of borrowing for firms changes, affecting operating capital and investment expenditure plans and, thus, aggregate demand. On the other hand, an increase in the interest rate generates a change in the relative price of present and future consumption and, therefore, an

intertemporal substitution of consumption that reduces current aggregate demand. It is noteworthy that in economies with high and volatile inflation, the level of the real interest rate is uncertain, which, among other factors, reduces the effectiveness of this simple channel.

In recent years, households' demand for credit in Mexico has shown a low sensitivity to interest rate movements. An explanation of this fact is that after the 1995 crisis, households faced several years of tight credit constraints and, as these constraints have started to loosen, households have increased their pent up demand for credit.

III.2 The credit channel

There are two main channels of monetary transmission that rely on credit market frictions: the bank-lending or narrow credit channel, and the balance sheet or broad credit channel. The bank-lending channel associates the effects of monetary policy to movements in the supply of bank credit, reducing economic activity through its effect on expenditures (investment, working capital, and consumption) of bank credit-dependent borrowers. There are two main explanations for the reduction in the supply of credit. The first view is related to adverse selection. An increase in the interest rate leaves a riskier pool of households and firms willing to borrow, which increases monitoring costs and induces credit rationing. The second view assumes that a monetary tightening drains liquidity from the banks (Bernanke and Blinder (1988)), inducing a reduction in banks' liabilities and increasing the costs of intermediation. A monetary policy tightening is usually assumed to reduce the ability of banks to obtain deposits. If banks cannot adjust their balance sheets by reducing their holdings of non-credit short-term assets, the supply of credit will decrease. Thus, the relevance of this mechanism depends on banks' ability to substitute deposits with other funds.[12]

The significance of the bank-lending channel depends on the number of bank-dependent borrowers and the quantitative impact of monetary policy on the supply of bank loans. Thus, in countries with no alternative sources of financing other than bank credit, this channel is likely to be more important. On the other hand, banking crisis episodes that generate a severe reduction in the supply of loans reduce the relevance of the credit channel of monetary policy.

With respect to the broad credit or balance sheet channel, the effects of monetary policy are derived from a propagation mechanism through the financial health of firms. In the presence of financial market imperfections, firms must pay a premium on external financing (from banks or any other external source), and this premium depends on the strength of its balance sheet. A firm with a higher net worth faces a lower cost of external finance. A monetary tightening can affect a firm's balance sheet in different ways: it increases the payments that the firm must make to service its debt, it reduces the firm's cash flow, and it reduces the net worth of the firm when the increase in interest rates reduces the price of borrowers' assets (equity, real estate, etc.). Therefore, the change in the cost of borrowing faced by a firm can differ from the change in the interest rate induced by monetary policy. The balance sheet channel has been termed the financial accelerator as it amplifies the initial effect of monetary policy (Bernanke et al (1999)).

In Mexico, the significant and lasting disruption of credit markets generated by the financial crisis of 1995 thwarted the operation of the traditional interest rate and credit channels of monetary transmission. A severe credit crunch took place after the crisis, and credit in some markets, like the mortgage market, practically disappeared for several years. This implied a

[12] Romer and Romer (1990) argue that following a monetary tightening, banks may issue money market liabilities to offset the drop in deposits. Nevertheless, the costs of these funds are generally higher than the cost of deposits.

severe tightening of credit constraints for firms and households. Commercial banks' direct credit to the non-financial private sector (households and firms) went from 39.5 percent of GDP in December 1994, to 7 percent in June 2002, and, excluding non-performing loans, these figures accounted for 35.9 percent and 6.1 percent of GDP, respectively.[13]

In recent years, commercial bank credit to the non-financial private sector has recovered significantly. In particular, credit to households has been the most dynamic component of commercial bank credit, with an average annual real growth rate of 30.2 percent during 2002-2006 (albeit from a still relatively low base). This expansion has implied a change in the structure of banks' portfolio, as the stock of credit to households has become, since the beginning of 2006, the main component of bank credit to the private sector.

Macroeconomic stability and the restoration of banks' financial health, among other things, have contributed to the recovery of bank credit to the private sector. Nevertheless, there are two important recent developments that deserve mention: (i) the reduction of banks' financing to the public sector borrowing requirements have freed bank resources, which, in turn, have been shifted towards credit to households and, more recently, towards small and medium enterprises (Figure 4);[14] and (ii) the development of financial markets has allowed large corporations to obtain financing at lower interest rates by issuing domestic securities.

These two developments have various outcomes. First, they imply an efficient reallocation of resources as both the government and large corporations can obtain cheaper financing in security markets, and banks can use their comparative advantage in monitoring and reducing information frictions, which, usually, are not as important when dealing with the government and large firms. Second, the reallocation of bank funds generates a loosening of credit constraints for households and medium and small firms. Since these sectors are the traditional bank-dependent borrowers, the bank-lending channel should strengthen. In addition, the easing of credit constraints has allowed households to maintain a smoother consumption pattern during the last business cycle. Finally, the development of private sector security markets is likely to strengthen the balance sheet and the asset price channels of monetary policy.

Households' low-levels of indebtness and greater access to credit help explain why their demand for credit has exhibited small interest rate elasticity in recent years. For example, the short-term interest rate increased by slightly more than 400 basis points during 2004, but credit to consumption continued to grow vigorously. On the supply side, the restoration of health to the banking system, improving credit information and contract enforcement, the increasing importance of non-bank financial intermediaries, lower financing needs from the public sector and the development of financial markets that allows large corporations to obtain financing through securities, have increased the resources available to finance the private sector. Ample liquidity in international financial markets has also played a role in increasing the supply of funds. These developments pose some challenges when attempting to evaluate the credit channel of monetary policy, as will be shown in the next section. Nonetheless, these should be transitory phenomena. As households approach their desired level of indebtedness and the one-off effects of the improvement in financial conditions wear off, the intertemporal substitution of consumption and the credit channel of monetary policy will tend to strengthen.

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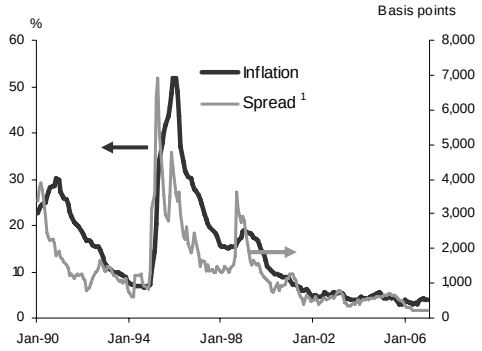
[13] These figures exclude the credit portfolio bought by Fobaproa to the commercial banks (Fobaproa is the Mexican deposit insurance corporation, now IPAB).

[14] The reduction of bank financing to the public sector borrowing requirements is a consequence of smaller public sector deficit, and the reduction of the stock of public sector contingent liabilities (mainly IPAB and debt restructuring programs) with commercial banks.

Figure 1

Inflation and spread of CETES and US 3-month T-bills



[1] Domestic interest rate (CETES) minus foreign interest rate (3-month T-bills).

Figure 2

Inflation and ratio of M4 to GDP

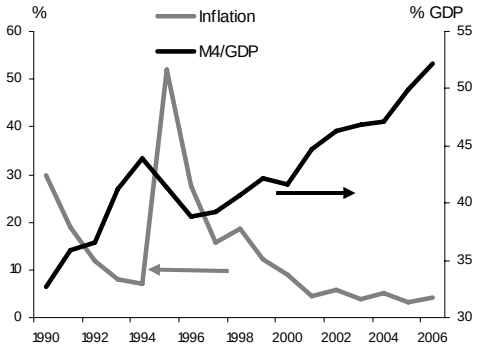


Figure 3

Average maturity and duration of government securities

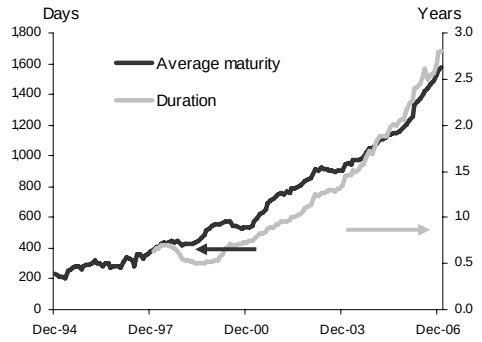
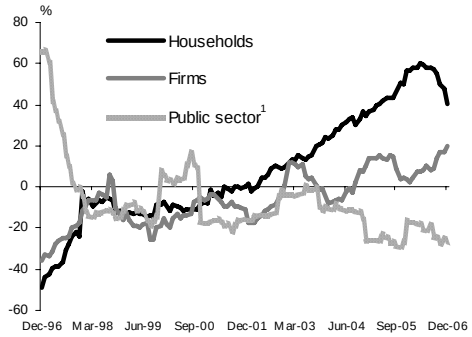


Figure 4

Commercial bank credit annual rate of growth



[1] Includes federal government, states and municipalities, IPAB, FARAC, PIDIREGAS, and debt restructuring programs.

III.3 The asset price channel

There are four categories of asset prices that provide important channels through which monetary policy affects the economy: securities' prices, stock market prices, real estate prices, and exchange rates. The exchange rate channel is treated separately due to its importance in emerging economies. The remaining asset price channels work mainly through wealth and balance sheet effects on households and firms.

In developed economies, the asset price channel is important for the household sector. Access to a broad set of financial and physical assets generates a large wealth effect when these prices move. The reduction in asset prices generated by a policy-induced increase in the interest rate depresses households' expenditure, particularly of consumer durable goods and housing.

For firms, Tobin's *q* measures the ratio of the value of the firm to its replacement cost of physical capital. Therefore, the lower the Tobin's q, the more costly financing of the firm will be, and a reduction in the price of its equity, generated by an increase in interest rates, makes investment more costly. On the aggregate level, a reduction in equity prices reduces investment, aggregate demand, and output. As mentioned before, a reduction in firms' value may also have an effect on economic activity as it implies a deterioration of their balance sheets and an increase in their cost of external financing.[15]

In developed economies, a change in the stance of monetary policy is transmitted through a rebalancing of agents' portfolios that affects the prices of other financial and durable assets and, thus, their rates of return. In many developing countries, the menu of assets available to private agents is more limited. Securities and equity markets lack the depth and capitalization to have a significant effect on the spending decisions of agents.

In the case of Mexico, the development of government and corporations' securities markets might produce a stronger asset price channel in the future. On the other hand, with respect to equity markets, the low level of market capitalization limits the effectiveness of this channel. In 2006, market capitalization represented 41 percent of GDP, while in economies like Chile and Brazil, it accounted for 120 and 67 percent of GDP, respectively.

With respect to real estate prices, although the mortgage market has shown a vigorous recovery in recent years, the current stage of development of financial markets still does not allow for a significant asset price channel through housing prices. The asset price channel of illiquid assets – such as real estate – requires agents to have wide access to financial markets and to be able to use their real estate equity to finance expenditures. Development of these markets in Mexico is still in its early stages. Nevertheless, in recent years, the development of the financial system has allowed other non-bank financial intermediaries to securitize mortgages, thus increasing the funding possibilities and allowing them to concentrate on generating mortgage credits.

III.4 The exchange rate channel

The conventional transmission mechanisms of the exchange rate work directly through its effect on import prices and through its impact on aggregate demand via net exports. When a monetary policy tightening increases the domestic interest rate relative to the respective foreign rate, equilibrium in the foreign exchange market calls for a gradual depreciation that reestablishes the no arbitrage condition. The expected future depreciation requires an initial appreciation that, when prices are slow to adjust, makes domestic goods more expensive relative to foreign produced goods, reducing net exports and, therefore, aggregate demand.

Nevertheless, the exchange rate appreciation may also have some other effects that counteract, at least partially, the reduction in net exports. In particular, movements in the exchange rate may have an impact on the balance sheets of financial and non-financial firms. When firms have important net liabilities denominated in foreign currency, an

[15] A recent debate related to the asset price channel is whether monetary policy should respond to movements in asset prices. Bernanke and Gertler (2001) argue that monetary policy should ignore movements in asset prices except insofar as they affect inflation expectations within the inflation targeting horizon. An opposite view is held by Cecchetti et al (2003), who argue that central banks should respond preemptively to asset price misalignments. Bean (2003) takes an intermediate position between both of these views, and argues that the macroeconomic implications of asset price movements and/or financial imbalances can be adequately embraced within an appropriately flexible and forward-looking concept of inflation targeting. Thus, monetary policy should take into account asset price fluctuations, to the extent that they provide information about the shocks affecting the economy or have implications for inflation and output in the medium term, beyond the usual inflation targeting horizon.

exchange rate appreciation may improve firms' net worth, reduce their cost of external financing and thus, increase aggregate demand.

Another mechanism by which movements in the exchange rate are transmitted to inflation works directly through their effect on inflation expectations. In particular, in some developing countries, a history of high and volatile inflation and unsuccessful exchange rate stabilization programs led to a strong indexation of inflation expectations to the exchange rate.

Most previous research about the transmission mechanism in México found that the exchange rate was the most important channel of monetary transmission, even after the adoption of a floating exchange rate regime. The estimated exchange rate pass-through to prices was considerably high. For example, Garcés (1999) estimated that after 12 months, 80 percent of a nominal depreciation was transmitted to prices. There is, however, growing evidence that the convergence to a low and stable inflation equilibrium has reduced the importance of the exchange rate in the formation of inflation expectations and in the price setting of agents.

III.5 The expectations channel

In recent years there has been a growing recognition of the importance of expectations about the future stance of monetary policy in improving monetary policy effectiveness in stabilizing inflation and output. Since there are costs in changing prices and renegotiating contracts, agents show forward-looking behavior in their setting of prices and wages.

When the commitment of monetary policy to reduce inflation is credible, its effectiveness is enhanced by its possibility to shape inflation expectations. Agents' expectations of the future stance of monetary policy feed back into the present, reducing the need for sharper movements in the interest rate to stabilize the economy. In the face of an expansionary demand shock (e.g. a temporary increase in public expenditure), if the commitment of monetary authorities to lower inflation is credible, agents anticipate a monetary policy response that will increase short-term interest rates to offset inflationary pressures. This perception anchors inflation expectations and thus, wage negotiations and the process of price determination are not contaminated. Since wages are in fact contained, there are no further increases in consumer demand nor in firms' labor costs (no second round effects). Furthermore, since the response of monetary policy to offset the shock is anticipated, firms' do not face a signal extraction problem, in the spirit of Lucas (1972), and their price setting process is not affected. On the other hand, in the presence of a cost-push shock, the credibility of monetary policy and the anchoring of expectations become more important as the central bank can accommodate the shock with fewer concerns about inflation expectations being contaminated. Credibility allows monetary policy to face an improved trade-off between stabilizing inflation and output, reducing the sacrifice ratio of inflation stabilization (see Clarida et al (1999) and Woodford (2001)). An important element in shaping inflation expectations is transparency of monetary policy, as it allows agents to have a better understanding of the central bank's reaction to different inflation pressures.

In Mexico, monetary policy's commitment to reduce inflation has gained credibility by responding in an appropriate manner to inflation shocks and a restrictive bias of monetary policy (Ramos-Francia and Torres (2005)). The benefits of this type of policy have been reflected in the anchoring of inflation expectations.

The way agents form their expectations has changed in recent years. While in the past inflation expectations seemed to be significantly affected by exchange rate fluctuations, the adoption of a floating exchange rate regime, the development of a foreign exchange rate market, and increased credibility of monetary policy have, among others, reduced the information content of nominal changes in the exchange rate for the formation of inflation expectations. All these developments point towards an increasing importance of the expectations channel of monetary transmission in Mexico.

IV. Inflation and the monetary transmission mechanism in Mexico

The stabilization measures and financial reforms undertaken in Mexico have increased the flexibility of the economy to adjust to different shocks. As previously stated, the resilience of the economy has been particularly enhanced by the adoption of a floating exchange rate regime and the inflation targeting framework, fiscal discipline and by the development of the financial system. Macroeconomic stability and an improved financial system have induced changes on the basic economic decisions of agents regarding expenditures, savings, labor, production, and price setting. In this respect, it is likely that the determinants of the nominal system of the economy, and thus the monetary transmission mechanism, have changed along with the policy changes and reforms.

Research on the monetary transmission mechanism has been scarce in Mexico. This is in part a consequence of the context in which monetary policy functioned in the past, and of the large disruption caused by the 1995 crisis. During the seventies and eighties, episodes of fiscal dominance, financial repression, and rigid exchange rate regimes, severely constrained monetary policy. Del Negro and Obiols-Homs (2001) studied the period 1975–1997 and did not find a significant effect of monetary policy on prices and output, while foreign shocks were the main determinants of these variables. As mentioned before, the exchange rate was considered to be the most important channel through which monetary policy was transmitted to the economy.

After several years of stable macroeconomic conditions and better functioning financial markets, it has become possible to perform empirical work about how these conditions have affected inflation and the channels of monetary policy transmission. The possibilities of analysis have greatly improved with respect to a decade ago. For example, in Gil (1998), the proximity of the 1995 crisis limited the possibility of a quantitative exploration of the transmission mechanism. The analysis in that paper was mainly concerned with explaining the monetary policy instrument “el corto”..[16]

The following sections present evidence that suggests that the inflation process and the transmission mechanism of monetary policy have changed. First, we present statistical evidence of these changes. For this purpose, we summarize Banco de México’s recent research that studies the properties of single variables (inflation and inflation expectations) and VAR analysis applied to the monetary transmission mechanism. The statistical analyses are complemented with a VAR exploration of the pass-through of the exchange rate to prices and of the credit channels of monetary transmission. Finally, we present evidence of the expectations channel of monetary transmission by recurring to the estimation of a small-scale macroeconomic model.

IV.1 Statistical evidence

This section summarizes research undertaken at Banco de México regarding the changes in the functioning of the nominal system of the economy, and provides new empirical work on some of the channels of monetary policy transmission.

[16] More recently, Baqueiro and Sánchez (2001) show some evidence on the operation of the credit channel in Mexico. They show that an increase in real short-term interest rates is associated with an increase in the spread between lending and deposit rates, and the change in the spread has an effect on the output gap. In addition, using firm level data, they explore the effect of the interest rate on suppliers’ trade credit using firm level data. They find that increases in the interest rate are associated with an important reduction in suppliers’ trade credit.

IV.1.1 Inflation dynamics

Inflation in Mexico has changed significantly. Research at Banco de México shows that, in recent years, inflation has undergone an important reduction in its mean and variance and has become less persistent.

Capistrán and Ramos-Francia (2006) show that these results are not exclusive to Mexico. These authors evaluate the stochastic process of inflation for a group of ten Latin American countries. Of this group, five countries have adopted inflation targeting (Brazil, Chile, Colombia, Mexico, and Peru), while the other five (Argentina, Bolivia, Ecuador, Uruguay, and Venezuela) have not.

Table 1

Inflation persistence in Latin America

Country	1990:01–199–12			2000:01–2006:06		
	α	90% confidence interval		α	90% confidence interval	
		Lower	Upper		Lower	Upper
Argentina	0.72	0.61	0.83	0.75	0.60	0.83
Bolivia	0.29	0.71	0.45	0.82	0.66	0.87
Brazil	0.83	0.66	0.95	–0.06	–0.52	0.81
Chile	–0.21	–0.57	0.58	0.18	0.01	0.42
Colombia	0.62	0.52	0.77	0.67	0.57	0.89
Ecuador	1.00	0.90	1.11	0.59	0.38	0.72
Mexico	0.95	0.88	1.02	0.31	0.17	0.54
Peru	0.25	0.01	0.69	0.28	0.12	0.50
Uruguay	0.22	0.02	0.55	0.85	0.67	0.97
Venezuela	0.79	0.72	0.93	0.96	0.83	1.13

Source: Capistrán and Ramos-Francia (2006).

Inflation persistence is measured by a scalar indicator "α", the sum of autoregressive coefficients of an AR(12) model for the CPI inflation rate. Table 1 presents this persistence measure for the countries under analysis using two samples, the first being for the period from January 1990 to December 1999, and the second from January 2000 to June 2006. The fact that the current degree of inflation persistence is, by historical standards, relatively low in at least six of the ten countries analyzed contrasts with the common view that high inflation persistence is a structural part of an economy, and favors the alternative that changes in monetary policy regime can affect inflation persistence. For example, except for Colombia, inflation persistence seems to have decreased or remained low in all inflation targeters, while it seems to have increased only in non-targeters. Thus the change in inflation persistence cannot be solely attributed to improved global economic conditions. The reduction of inflation persistence in Mexico seems to be significant, as the (point) measure of persistence moved from 0.95 during the nineties, to 0.30 after 2000.

Another important issue related to inflation persistence is whether the inflation series can be represented by a stationary process around a constant mean or a decreasing trend, or whether it is a non-stationary process that follows a stochastic trend. This question is

particularly relevant for a country that has adopted an inflation targeting framework, since the main objective of an inflation-targeting central bank is to deliver an inflation rate that is stationary around the target. Chiquiar, Noriega, and Ramos-Francia (op cit) study the change in persistence of the inflation process in Mexico and find that after the end of 2000, CPI inflation can seemingly be characterized as a stationary process around a decreasing trend, while before it was non-stationary. Similar results hold for core inflation.

IV.1.2 Structural changes in the monetary transmission mechanism

The change in the dynamics of inflation raises further questions on whether there have been changes in the reaction of monetary policy and in the overall transmission mechanism of monetary policy. These questions can be explored using vector autoregressive estimations. VARs are commonly used statistical methods to obtain a broad picture of the monetary transmission mechanism.

Before presenting our VAR estimation to identify some channels of monetary transmission, we present previous research done at Banco de México that uses a Markov Switching VAR (MS-VAR) analysis. MS-VARs are useful because they help to identify different regimes (structural breaks) that have prevailed over time. These regimes are identified according to three criteria: the level of the variables, their volatility, and the dynamic relationship between them, captured by the VAR, which is set to describe the monetary transmission mechanism. If a change in the policy rule results in a significant change in the listed criteria, it will be identified as a regime change. In this way, this methodology, at least partially, is less subject to the Lucas Critique than a traditional VAR framework for the study of the monetary transmission mechanism.[17]

Gaytán and González-García (op cit) study the monetary policy transmission mechanism in Mexico using an MS-VAR model, and present evidence that suggests that an important structural change in this mechanism took place around the beginning of 2001. Their model includes the real exchange rate, a measure of activity (the output gap), core inflation, inflation expectations, and the interest rate. In addition, it includes some exogenous variables to control for certain world outcomes: the federal funds rate, the rate of growth in the US manufacturing sector, US commodities (merchandise) inflation – to control for global disinflation – and some measures of international commodity and oil prices.[18]

The regime that prevails at each point in time is given by the probabilities that the estimation assigns to each of the different regimes. Figure 5 shows that the methodology is able to identify clear regime shifts over the sample period September 1993 to February 2005.[19] Although the regimes estimated are for the system as a whole, it is illustrative to see core inflation in light of the different regimes identified.[20]

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[17] In addition to changes in the policy rule, during periods of financial turbulence it is possible to observe both an increase in the variance of the shocks and an exceptional response of monetary policy. The proposed methodology is helpful in avoiding the problems associated with these cases.

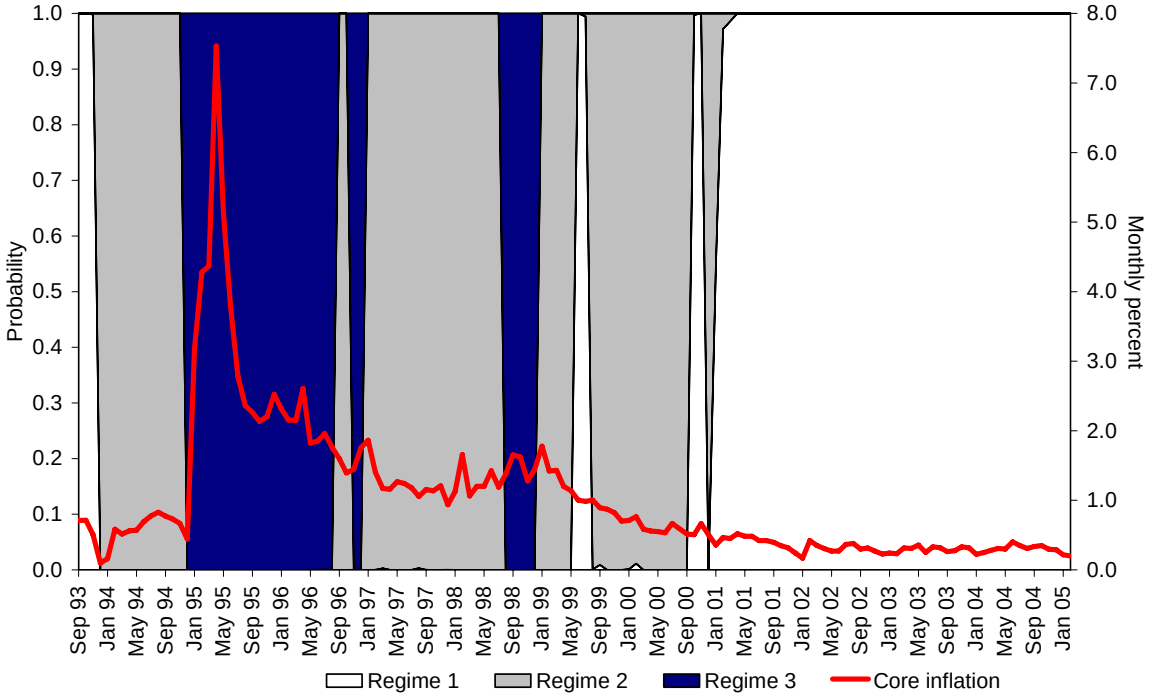
[18] The set of variables included is consistent with a large class of small open economy models (Galí and Monacelli (2002) and Svensson (2000)) that include an uncovered interest rate parity condition, an aggregate demand (IS) equation, a Phillips curve, and a policy reaction function of the central bank.

[19] The regimes identified in this paper are robust to the use of an updated sample.

[20] The inflation data is the seasonally adjusted monthly core inflation rate.

Figure 5

Regime probabilities and core inflation



Regime 3 is characterized by periods of financial turmoil; the aftermath of the 1995 crisis, and the period of international financial turbulence observed during the second half of 1998. Thus, the regime is associated with unstable macroeconomic conditions.

Regime 2 prevailed mainly after the worst of the turmoil associated to the 1995 crisis and up to the end of 2000 (except for the period of financial turbulence of 1998). Under this regime, both the level and volatility of inflation are intermediate, and there is a process of disinflation. Finally, Regime 1 has been the prevalent regime since January 2001. In terms of the inflation process, the regime is characterized by low, stable, and less persistent inflation. It is interesting to note that the change to the stable regime coincides with the change in inflation persistence as reported in Chiquiar, Noriega and Ramos-Francia (op cit).[21]

The analysis of the implications of the changes in regimes on the monetary transmission mechanism is performed using impulse responses to different shocks. Since Regime 3 was very unstable, only Regimes 1 and 2 were compared, corresponding broadly to the differences in the transmission mechanism after and prior to 2001.

After 2001, the response of all variables to real exchange rate shocks has diminished. In particular, the response of inflation and inflation expectations to these shocks has decreased significantly. Figure 6a shows the impulse-response of inflation to a 1 percent real exchange rate depreciation: after 2001, inflation responds less to real depreciations than in the previous period. A greater proportion of real exchange rate shocks have been accommodated through changes in the nominal exchange rate rather than by changes in inflation differentials, thus suggesting a less costly adjustment mechanism to real shocks.[22]

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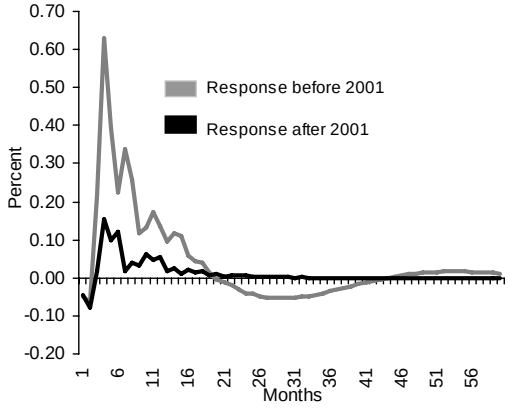
[21] An important remark is that, although the date of this change also coincides with the formal adoption of inflation targeting, it does not mean that the adoption of this policy regime prompted the aforesaid regime change. By the time inflation targeting was formally adopted, the macroeconomic policies and financial reforms undertaken in previous years had consolidated macroeconomic stability and contributed to change the dynamics of the inflation process and the monetary transmission mechanism.

[22] These results do not mean that the adoption of inflation targeting prompted the aforesaid change in the inflation regime, only that the change in regime took place around the time inflation targeting (IT) was formally implemented.

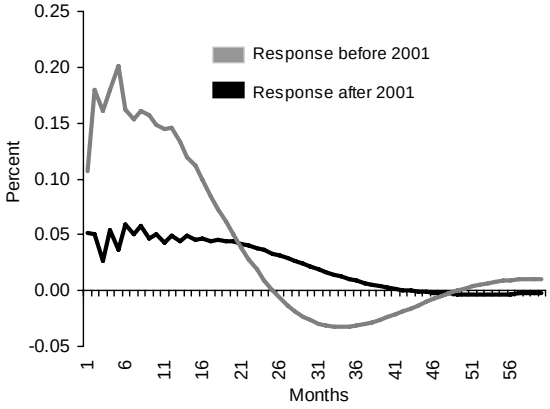
Figure 6

The monetary transmission mechanism MS-VAR response to a 1% impulse

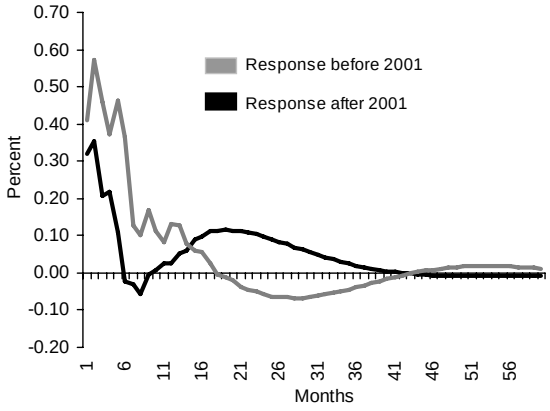
(a) Response: inflation
Impulse: real exchange rate



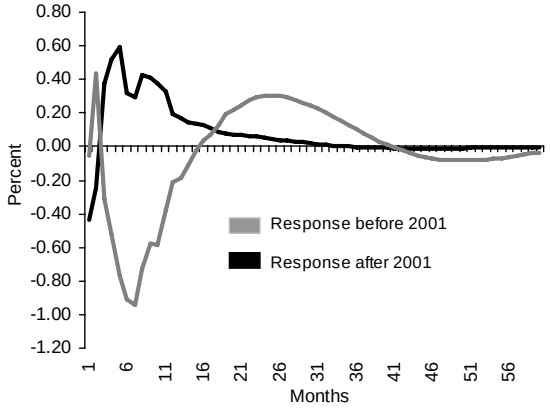
(b) Response: inflation expectations
Impulse: real exchange rate



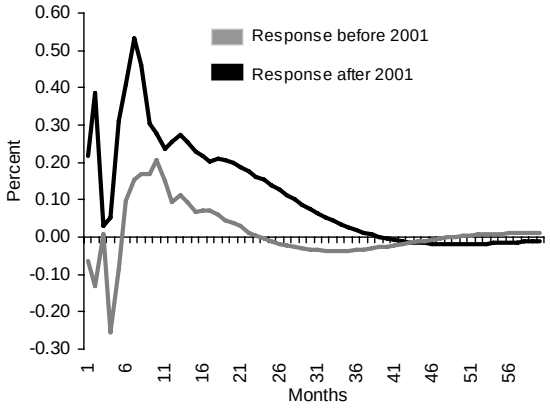
(c) Response: nominal interest rate
Impulse: real exchange rate



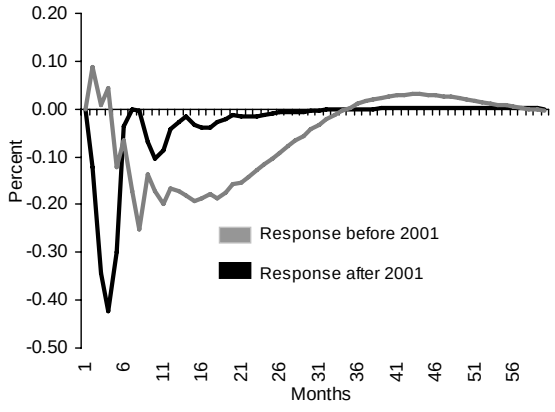
(d) Response: nominal interest rate
Impulse: output gap



(e) Response: nominal interest rate
Impulse: inflation



(f) Response: inflation
Impulse: nominal interest rate



Source: Gaytán and González-García (op cit).

The response of inflationary expectations to real exchange rate shocks has also decreased (Figure 6b). As the nominal exchange rate becomes a shock absorber variable, a real depreciation is now perceived more as a change in relative prices and less as a signal of movements in the general price level. Therefore, as real exchange rate shocks generate less inflation pressures and do not contaminate inflation expectations, we would expect the central bank to react less to these shocks. Figure 6c shows that in Mexico the response of the interest rate to this type of shock has also become milder.

Deviations of output from its potential level call for a response of the interest rate, as otherwise this situation would lead to inflation deviating from its target. In this context, there has been an important change in the reaction of monetary policy to output gap shocks. After 2001, output gap pressures generate a strong reaction of interest rates (Figure 6d). The response of the interest rate to inflationary shocks has also become stronger and more persistent (Figure 6e).

This research also shows that interest rate changes have become more effective in producing a faster and stronger reduction of inflation (Figure 6f). Nevertheless, in the estimated model, an interest rate increase generates a reduction in the output gap only after six periods. Therefore, the traditional interest rate channel, which is the main channel embedded in this VAR model, cannot account for the strong and fast reduction of inflation after an interest rate movement. This last result calls for further exploration of other channels of monetary transmission, which are presented in the next sections of this paper.

IV.1.3 Changes in inflation expectations

Some of the recent research undertaken at Banco de México has been devoted to study the changes in the anchoring of inflation expectations and of the relative importance of the forward- and backward-looking components of the inflationary process in explaining its short run dynamics.

Regarding the anchoring of inflation expectations, Capistrán and Ramos-Francia (2007) show evidence that suggests that inflation targeting has contributed to the anchoring of inflation expectations. The anchoring of expectations is analyzed by studying the reduction in the dispersion of expectations among market forecasters. Under inflation targeting, if agents have confidence in the central bank policy, the optimal inflation forecast – for horizons larger than the control lag of monetary policy – is the inflation target itself. Since this principle applies to each forecaster, under an inflation targeting regime, the variance among forecasters should decrease and the distribution of forecasts should eventually collapse around the target. The paper shows, using 16 years of monthly data from 14 inflation targeters and 12 countries that have not adopted this policy framework, that the dispersion of inflation expectations is lower in targeting regimes, and that this effect is driven by emerging economies. These results are obtained after controlling for country-specific effects, time-specific effects, initial dispersion, the level and the variance of inflation, disinflation periods, and global disinflation.

Ramos-Francia and Torres (2006) use a New Phillips curve framework (Galí and Gertler (1999)) to analyze whether in recent years, as the economy has been converging towards a low inflation environment, the short-run dynamics of inflation have experienced significant changes. In particular, they analyze the changes in the relative importance of the backward- and forward-looking components of inflation for two samples, the first being the complete sample for the period from January 1992 to June 2006 and, the second, the sub-sample January 1997 to June 2006. According to the model used, the results suggest that the fraction of firms that sets their prices using a backward-looking rule of thumb has decreased, and that the forward-looking component of the inflation process has become more important.

IV.1.4 The nominal exchange rate and the credit channels

The evidence presented so far is a starting point to perform additional work on the changes that have occurred in other channels of monetary transmission. In this section we present an exploration of the nominal exchange rate and the credit channels of monetary policy. For this purpose, we estimate a VAR for the period June 1996 to August 2006. We split the sample onto two periods using the dates of Regimes 1 and 2 of the MS-VAR exercise. The first period is from June 1996 to December 2000, and the second period from January 2001 to August 2006.

The set of variables included in this estimation is similar to the one proposed by Morsink and Bayoumi (2001). We perform two estimations: first, we estimate a basic model with a reduced set of endogenous variables; this estimation is performed to compare the results with those presented in Gaytán and González-García (op cit). The main purpose of this comparison is to confirm that their results are not dependent on the set of variables they used. In particular, they only include one monetary variable (the nominal interest rate), while to analyze the effect of an interest rate change that is not originated by a change in money demand, it is necessary to include both the interest rate and a monetary aggregate. The basic model includes the following variables: (i) the output gap; (ii) CPI inflation; (iii) the short term nominal interest rate; (iv) the annualized rate of growth of M1 balances; and (v) the depreciation of the nominal exchange rate.[23] The measure of the stance of monetary policy is, in this case, the short term interest rate.[24, 25]

The results of the basic model confirm that in recent years monetary policy shocks have had a stronger and faster effect on prices. The other results are also similar to those of Gaytán and González-García (op cit), and are not reported for brevity.

For the second estimation, the basic model is then extended to study the credit channel of monetary transmission. Three additional variables are included: (vi) the rate of growth of real bank credit to households; (vii) the rate of growth of real bank credit to firms; and (viii) the rate of growth of the real stock of securities issued by corporations.[26]

Empirical results

The empirical analysis is performed using impulse response functions and variance decompositions. For the impulse response analysis, we present the cumulative responses of the variables included to a 1 percent shock. The accumulated impulse responses are used because, in some cases, we are interested in the effect of the impulses on the level of the other variables (for example, for the pass-through effect, the accumulated impulse response shows the change in the price level to a 1 percent depreciation).

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[23] Since we are interested in determining the change in the pass-through from the exchange rate to prices, we use nominal depreciation. In contrast, Gaytán and González-García's (op cit) use of the real exchange rate is useful to illustrate how the way in which the economy absorbs these shocks has changed.

[24] To identify the shocks, we assume a recursive structure (Choleski decomposition) according to the order in which the variables are presented. These assumptions are frequently used in the study of the monetary policy transmission mechanism (see Christiano et al (2000)).

[25] The variables used are defined as follows: i) the output gap is estimated using the HP filter; ii) CPI inflation is annualized monthly inflation rate; iii) the short term interest rate is the 28-day CETES rate; iv) the rate of growth of M1 is the annualized rate of growth of M1; and, v) the depreciation of the nominal exchange rate is the rate of change of the fix nominal exchange rate.

[26] These variables are included before the nominal exchange rate variable, under the assumption that the nominal exchange rate can adjust to the information contained in the rest of the variables. This order is similar to the one used by Morsink and Bayoumi (op cit).

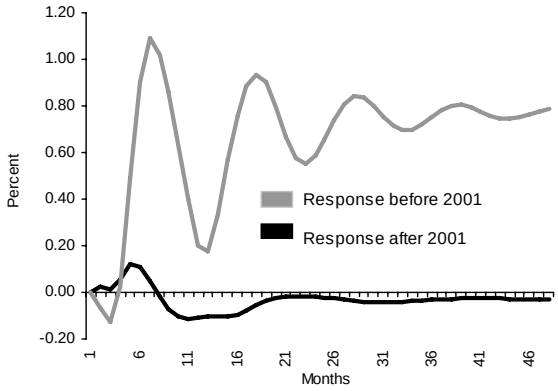
The first exploration under this credit model is to analyze the changes in the pass-through of the nominal exchange rate to prices. Figure 7a presents the response of prices to a nominal exchange rate depreciation of 1 percent. The results confirm an important reduction in the pass-through effect. Prior to 2001, a depreciation of 1 percent generated a long-run increase in prices of around 0.8 percent, a result consistent with the one reported by Garcés (op cit). In the new regime, after 2001, the cumulative effect on prices of a nominal depreciation is close to zero. The direct effect of the nominal depreciation has been greatly reduced; however, there is an indirect effect through output. In the sample 1996–2000, the nominal depreciation had a negative effect on output, possibly reflecting that after the crisis the balance sheets of government, households and firms remained vulnerable to exchange rate fluctuations. After 2001, a nominal depreciation, with a small response of prices, generates a real exchange rate depreciation and output exhibits the usual increase of a small open economy (Figure 7b).

When analyzing the direct effect of interest rate changes on both the output gap and inflation, the following results are obtained: economic activity contracts less sharply during the new regime than prior to 2001 (Figure 7c). On the other hand, in recent years, an interest rate increase generates a faster and stronger direct reduction of inflation than before (Figure 7d). Both results are similar to those reported by Gaytán and González-García (op cit).

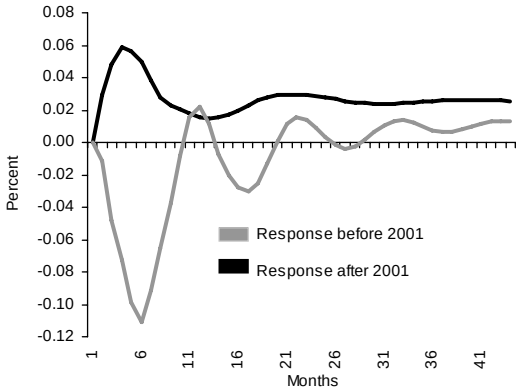
Figure 7

Credit channel model response to a 1% impulse

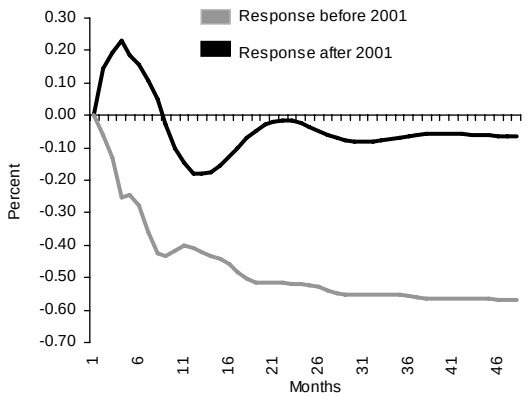
(a) Response: prices
Impulse: nominal exchange rate



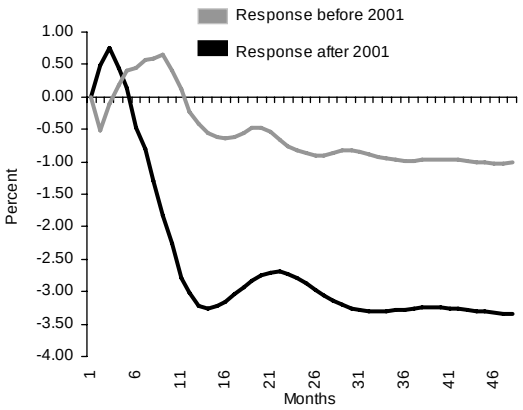
(b) Cumulative response: output gap
Impulse: nominal exchange rate



(c) Cumulative response: output gap
Impulse: interest rate



(d) Response: prices
Impulse: interest rate



The second exploration consists of analyzing the private sector funding variables so as to study the changes in the credit channel of transmission. Bank financing to firms shows a positive, although transitory, effect on the output gap in recent years (Figure 8a). The response of this type of credit to interest rate shocks is negative under both regimes (Figure 8b).

Corporations' financing through securities has a positive effect on the output gap (Figure 8d). The effect is strong if we consider the relative small size of this type of financing – the stock of securities of the private sector to GDP represents less than 3 percent – and this type of financing is concentrated in a few large firms. This type of financing diminishes as a result of increases in the interest rate under both regimes; however, the reduction under the new regime is faster and stronger (Figure 8c). This result may suggest the existence of a broad credit channel of monetary policy.

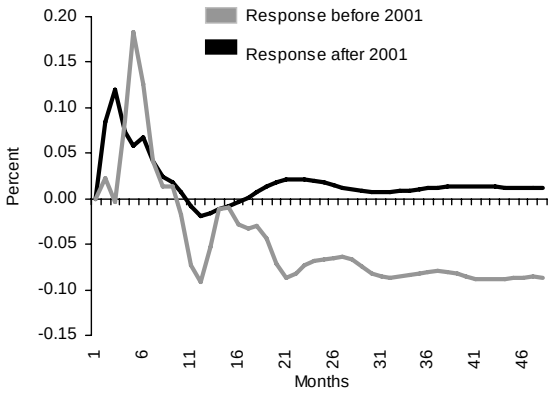
The effect of bank credit to households on economic activity has changed significantly. After 2001, an increase in this credit is associated with an increase in the output gap, while prior to this date the effect is negligible (Figure 8e). Tight credit restrictions that households faced after the crisis and the increased availability of credit to this sector in recent years are the most probable explanation of this result. As for the effect of the interest rate on this type of credit, there is a positive effect on bank credit to households (Figure 8f). This result, which at first seems contradictory, may reflect some important developments in banking in recent years. In particular, on the demand side, the recent loosening of the credit constraints that households faced in combination with its low indebtness levels explain households' low interest rate elasticity of demand for banking credit.Thus, a possible explanation of the positive response of households' credit to an interest rate increase in recent years is the process of financial deepening. The number of households that have had access to credit, particularly to consumption credit, has increased significantly in recent years. Therefore, we include the number of credit cards in the VAR estimation as a proxy variable to control for this process of financial deepening. The dotted line in Figures 8e and 8f show the results of this exercise for the period after 2001. After controlling for household access to credit, the output gap response to an increase in credit is practically unchanged with respect to the previous exercise, but, the response of this type of credit to interest rate increases practically disappears, as prior to 2001. These results suggest that over the last decade the transmission mechanism through household credit is not yet fully operational. Nevertheless, we could expect that as households' access to credit reaches steady levels and households attain their desired level of indebtedness, the credit and the traditional interest rate channels will strengthen.

The variance decomposition comparison between the different regimes confirms the reduced importance of exchange rate shocks in determining all variables, particularly inflation. While prior to 2001, nominal depreciations explained 25.6 percent of the variance of inflation, this share has declined to 3 percent. Regarding private sector financing variables, inflation explains a smaller fraction of their variance after 2001 than in the previous period, especially for household financing, which decreases from 24 percent to only 6.1 percent. In recent years, the output gap has become a more significant variable in explaining changes in bank credit to firms, while the share of fluctuations in household credit explained by this variable is reduced.

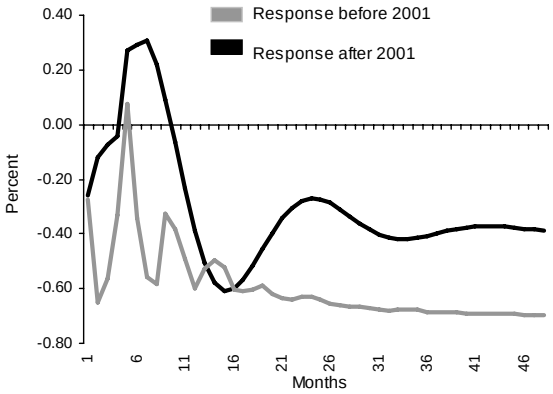
Figure 8

Credit channel model, credit variables response to a 1% impulse

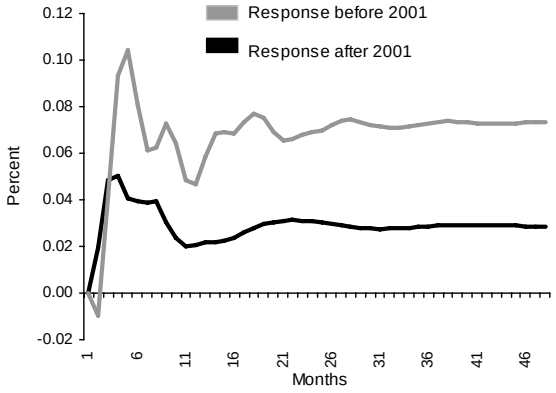
(a) Cumulative response: output gap
Impulse: bank credit to firms



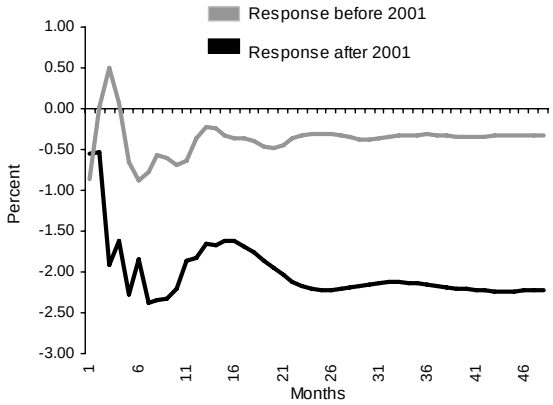
(b) Cumulative response: credit to firms
Impulse: nominal interest rate



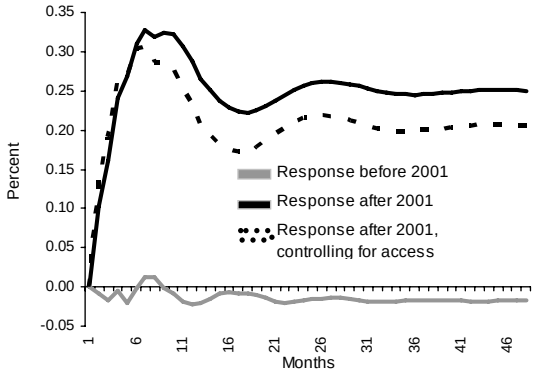
(c) Cumulative response: output gap
Impulse: private securities



(d) Cumulative response: private securities
Impulse: interest rate



(e) Cumulative response: output gap
Impulse: household credit



(f) Cumulative response: household credit
Impulse: interest rate

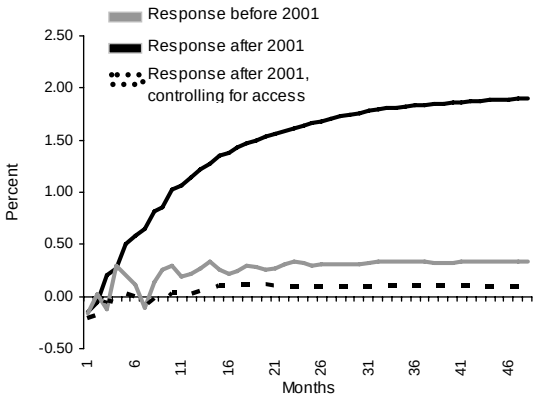


Table 2

Variance decomposition. Forecast horizon: 5 years

	Forecast error	Output gap	Inflation	Nominal interest rate	Money	Bank credit to households	Bank credit to firms	Securities of the private sector	Nominal exchange rate
Regime 2 (before 2001)									
Output gap	1.4	39.3	12.5	5.4	2.2	0.4	14.0	11.8	14.5
Inflation	11.2	13.0	30.6	2.2	2.3	1.7	18.6	6.0	25.6
Nominal interest rate	3.2	12.2	5.2	35.3	1.6	1.5	21.2	5.9	17.0
Money	7.5	7.0	6.7	5.4	63.6	1.9	3.8	6.9	4.6
Bank credit to households	6.7	9.1	24.0	2.8	4.9	13.4	27.7	6.4	11.7
Bank credit to firms	4.8	4.5	7.4	9.2	6.0	6.9	53.6	4.9	7.5
Securities private sector	9.9	10.5	6.8	7.7	5.9	2.7	13.7	37.3	15.4
Nominal exchange rate	21.2	20.4	6.4	7.5	2.4	0.7	23.2	6.5	32.9
Regime 1 (after 2001)									
Output gap	0.9	65.4	2.9	3.4	7.6	4.9	6.0	2.4	7.4
Inflation	4.8	11.4	68.9	4.7	3.7	2.8	3.1	2.6	3.0
Nominal interest rate	2.6	27.8	4.4	34.7	5.7	14.5	2.7	3.4	6.8
Money	11.4	4.9	8.6	8.9	55.8	4.5	2.6	7.8	6.8
Bank credit to households	1.7	5.3	6.1	4.4	7.5	59.6	6.8	6.6	3.7
Bank credit to firms	2.6	17.2	3.9	2.4	13.3	2.8	56.1	0.9	3.4
Securities private sector	5.2	7.3	4.4	6.2	12.5	12.2	2.9	52.4	2.1
Nominal exchange rate	16.6	5.8	2.0	7.2	3.7	7.6	5.5	6.5	61.7

IV.2 The monetary transmission mechanism and inflation expectations

The results presented in Sections IV.1.2 and IV.1.4 are based on VAR analysis. Although this methodology is adequate in providing a broad picture of the monetary transmission mechanism, it has some shortcomings; in particular, it is ill-suited to identify the role of

inflation expectations in the monetary transmission mechanism.[27] In this section we perform an exercise using a simple model that can account for the expectations channel. We use a standard rational expectations small-scale macroeconomic model of the New Keynesian type.

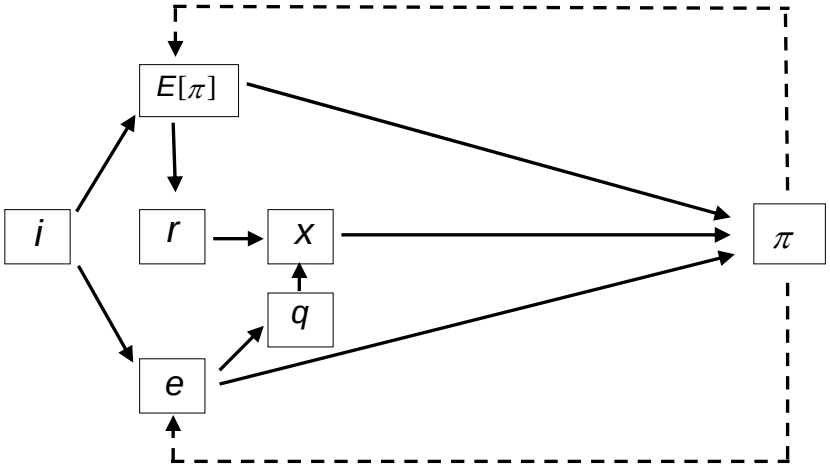
The model is composed of four behavioral equations: (i) a Phillips curve for core inflation; (ii) an IS equation for the output gap; (iii) a real exchange rate equation; and (iv) a Taylor type monetary policy rule for the nominal interest rate. As is common in this type of models, the dynamics are driven by shock innovations on these equations (see Appendix).

The model has a simple structure and belongs to the class of models termed "hybrid", incorporating micro-founded forward- and backward-looking elements. The inclusion of lags and expectations of the variables in the equations is necessary to replicate the dynamics of the observed series. Lagged information can be relevant because of different real and information rigidities.[28] However, as the economy becomes more flexible and monetary policy gains credibility, the importance of the inertial component will tend to decrease.

Figure 9 presents the monetary transmission mechanism implied by this model. The effect of the monetary policy instrument (the nominal interest rate, i) on inflation, π, in the short-run works through three channels: a) inflation expectations, $E[\pi]$, and its direct effect on inflation (Phillips curve); b) the real interest rate, r, (through inflation expectations) and its effect on the output gap, x (IS equation); and, c) the nominal exchange rate, e, that, on the one hand has a direct effect on inflation (Phillips curve), and on the other -given price rigidities- affects the real exchange rate, q, in the short run, which, in turn, affects the output gap (IS equation).

Figure 9

The transmission mechanism of the model



[27] The inclusion of survey information on inflation expectations as an endogenous variable in the VAR may help to mitigate the price puzzle, but it does not account, in a proper way, for an adequate specification of rational expectations since there is no specific rule to assure consistency between survey information and the rational expectations implied by the estimated model.

[28] For example, if consumption habits are important, the output gap will depend on its own lags (McCallum and Nelson (1999)). In addition, when there is imperfect information, agents may set their prices according to a rule of thumb to past inflation (Galí and Gertler (op cit)).

The model presented is used to perform an exercise to ilustrate the changes in the monetary transmission mechanism in Mexico. As summarized in this paper, evidence suggests that the dynamics of inflation and the monetary transmission mechanism experienced important changes around the end of 2000 and the beginning of 2001. Thus, we divide the sample into two sub-samples: the first sub-sample goes from 1996 to 2000, and the second sub-sample from 2001 to 2006. The model and the corresponding parameter estimates for both sub-samples are reported in the Appendix.

The estimations for the two sub-samples show that in recent years there has been a significant increase in the forward-looking components of both the Phillips curve and the IS equation, and a reduction in the backward-looking elements. In the Phillips curve, the coefficient of the forward-looking component of core inflation increased from 0.53 to 0.66; therefore, the effect of inflation expectations in determining inflation has increased in recent years..[29] This result implies that when the commitment of monetary policy to maintain inflation around a specific target is credible, in the presence of inflationary shocks, inflation deviations from this target fade out faster and the persistence of inflation decreases. In the IS equation, the fact that the output gap depends on expectations for its own future value (forward-looking component) implies that it is not only affected by the current values of the real interest rate and the real exchange rate, but also by the expected path of these two variables. Therefore, the increase in the relative importance of the forward-looking component of the IS equation in recent years (the corresponding coefficient increased from 0.17 to 0.57) implies that the effect of a given expected path of real interest rates on aggregate demand is stronger..[30] Thus, this result suggests that in recent years the ability of monetary policy to affect aggregate demand has increased.

Since a cost-push shock to core inflation generates a trade-off for monetary policy between stabilizing inflation and output, it is illustrative to analyze the changes that the economy has undergone in response to this type of shock (Figure 10)..[31] A once-and-for-all shock to core inflation increases inflation and reduces the output gap on impact. To contain the effect of the shock on inflation expectations and to lead inflation back to its initial level, the response of monetary policy is to increase the interest rate temporarily. This increment in the interest rate leads to a further reduction in the output gap that contributes to reduce inflation. As the interest rate and inflation return to their initial levels, the effect on the output gap vanishes.

Results in Figure 10 show that after 2001 the increase in the relative importance of the forward-looking components of inflation and output have implied a change in the adjustment of the economy to a cost-push shock. Since the importance of inflation expectations in determining inflation has increased and results show that the response of inflation to the shock is less persistent in the second sub-sample, inflation expectations appear to be better anchored in recent years. Also, given that the effect of monetary policy on aggregate demand is stronger after 2001, the necessary response of the interest rate to contain inflation expectations and to lead inflation back to its initial level is smaller, reducing the cost of stabilizing inflation in terms of the output gap.

In sum, the previous exercise sheds light on the increasing importance of the expectations channel of monetary policy in recent years. There has been a significant change in the

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[29] This change is statistically significant. The 95% confidence interval of the forward-looking component of the Phillips curve is [0.526, 0.528] prior to 2001, and in the second sub-sample it is [0.649,0.679**]**.

[30] This change is statistically significant. The 95% confidence interval changed from [0.122,0.214] in the first sub-sample to [0.556,0.582] after 2001.

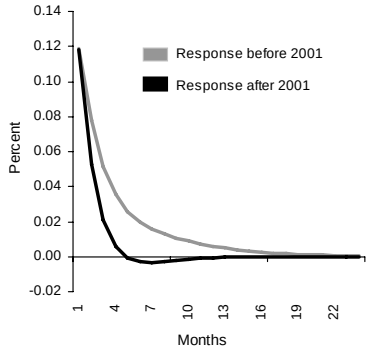
[31] The shock is assumed to have no persistence and is a once-and-for-all innovation with zero mean and constant variance.

forward-looking components of price setting and aggregate demand. These changes have implied that monetary policy has become more effective in reducing inflation pressures.

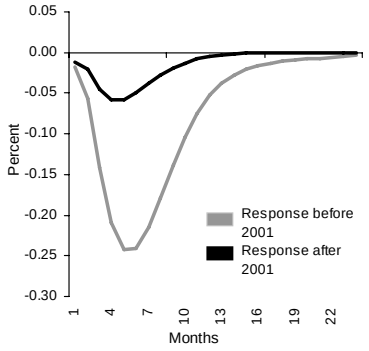
Figure 10

Small-scale model, response to a one percentage point cost-push shock

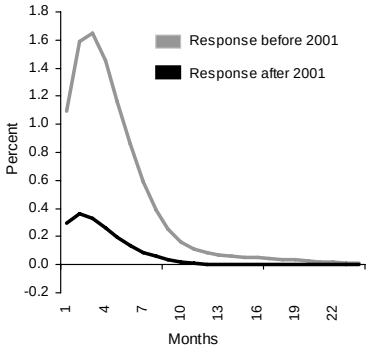
(a) Response: core inflation



(b) Response: output gap



(c) Response: nominal interest rate



V. Final remarks

Over the last decade, the inflation process and the monetary policy transmission mechanism have changed significantly in Mexico. Several factors account for this result. On the one hand, the world economy has followed a disinflation trend; on the other, fiscal discipline and the proper response of monetary policy to inflationary pressures have been crucial elements to understand the changes that have taken place. First, the level and volatility of inflation have decreased, and the inertial component of the inflation process has been considerably reduced. Second, the reduction in persistence has implied that, in recent years, the inflation process seems to have become clearly stationary, which is a necessary condition for a proper functioning of the inflation-targeting monetary policy framework.

In recent years, there is also evidence of changes in the monetary transmission mechanism. Exchange rate fluctuations have become less important in the determination of prices. On the other hand, interest rate movements have had a faster and stronger effect on inflation. These changes, together with increased transparency in the implementation of monetary policy have modified the determinants of inflation expectations and the whole price setting process. As a result, the Mexican economy has witnessed an exceptional long period of macroeconomic stability in recent history.

The restoration of health in the banking system, and the development of financial markets in recent years, may imply that in the future certain channels of monetary transmission will gain relevance. In particular, the narrow and broad credit channels could become more important. There is some preliminary evidence of the functioning of these channels in firms' financing. Nonetheless, the bank-credit channel operating through credit to households is not yet fully operational. This could be a consequence of a recent and unprecedented loosening of credit constraints, together with an important supply of funds to this sector. In that case, as households replenish their stock of durable consumption goods and attain their desired levels of indebtedness, this type of credit will probably become more responsive to changes in interest rates.

The faster and stronger response of inflation to changes in the stance of monetary policy cannot be completely accounted for by the traditional interest rate channel or by the credit channel of monetary transmission. Evidence presented in this paper suggest that the expectations channel of monetary policy seems to be the most probable explanation for this change. In recent years, agents have changed both the information used to form their expectations and the importance of expectations in their price setting and expenditure decisions. All these changes reflect an increased credibility in the commitment of fiscal and monetary policies in pursuing macroeconomic stability and a more flexible economic system, that allows a faster adjustment of the economy to different shocks at a lower cost.

In sum, the Mexican experience shows that the transition from high and volatile to low and stable inflation generates important changes in the way the nominal system, and thus the real economy, work with significant implications for monetary policy and benefits to the economy.

Appendix

The small-scale hybrid model

The specification of the monthly hybrid model of Section IV.2 consists of the following behaviour equations (i to iv) and one identity (v):

Equation:

(i) Phillips curve $\pi_t^c = a_1\pi_{t-1}^c + a_2E_t\left[\pi_{t+1}^c\right] + a_3x_t + a_4(\Delta e_t + \pi_t^{US}) + \upsilon_t$

(ii) IS curve $x_t = b_1x_{t-1} + b_2E_t\left[x_{t+1}\right] + b_3r_{t-1} + b_4x_t^{US} + b_5q_t + u_t$

(iii) Real exchange rate $q_t = c_0(q_{t-1}) + c_1(E_t\left[q_{t+1}\right] + (r_t^{US} - r_t)) + w_t$

(iv) Taylor type rule $i_t = (1-d_3)\left((d_1(\pi_t^A - \pi_t^*) + d_2x_t\right) + d_3i_{t-1} + \varepsilon_t$

(v) CPI inflation definition $\pi_t \equiv \omega_c\pi_t^c + \omega_{nc}\pi_t^{nc}$

Where: π_t is the monthly CPI inflation rate, $\pi^c{}_t$ is the monthly core inflation, $\pi^{nc}{}_t$ is the monthly non-core inflation, $\pi^A{}_t$ represents annual inflation, $\pi^*{}_t$ is the annual inflation target, x_t the output gap (estimated using a monthly indicator of GDP, IGAE, and an HP filter), e_t the nominal interest rate, q_t the real exchange rate, i_t the nominal interest rate, r_t the real interest rate, and $\pi^{US}{}_t$ and $x^{US}{}_t$ denote the US monthly inflation and the US output gap (estimated using industrial production and an HP filter), respectively. The first four equations include the shock innovations that drive the dynamics of the model: v_t, is a cost-push shock, u_t is a demand shock, w_t a shock to the real exchange rate, and ε_t is a monetary policy shock. These shocks are assumed to be normally distributed with zero mean, constant variance, serially uncorrelated, and orthogonal to each other.

Following the literature on the estimation of this type of models, to avoid the problem of endogeneity of expectations the Generalized Method of Moments (GMM) method is used to estimate the equations.

(i) The estimated Phillips curve for the two sub-samples are as follows:

Table A1

Phillips curve[1]

Sample	π_{t-1}^C	$E_t\left[\pi_{t+1}^C\right]$	x_t	$\Delta e_t + \pi_t^{US}$
1996–2000[2]	0.458	0.527	0.011	0.015
	(0.0006)	(0.0007)	(0.0000)	(0.0001)
2001–2006[3]	0.333	0.664	0.013	0.003
	(0.0076)	(0.0076)	(0.0006)	(0.0076)

[1] Standard deviations reported in parenthesis. [2] The sample used for the estimation is from July 1996 to September 2000. The set of instruments is: a constant; πt-1 to πt-5; Δet-3 to Δet-12; rt-1 to rt-12 and xt-3 to xt-18. [3] The sample used for the estimation is from January 2001 to August 2006. The set of instruments is: a constant; πt-6 to πt-12; Δet-3 to Δet-18; rt-1 to rt-18 and xt-3 to xt-18.

(ii) The estimated IS equation for the two sub-samples are as follows:

Table A2

IS equation[1]

Sample	x_{t-1}	$E_t[x_{t+1}]$	r_{t-1}	x_t^{US}	q_t
1996–2000[2]	0.565	0.168	–0.061	0.139	1.749
	(0.0320)	(0.0237)	(0.0081)	(0.0424)	(0.8887)
2001–2006[3]	0.312	0.569	–0.035	0.219	1.415
	(0.0104)	(0.0066)	(0.0033)	(0.0058)	(0.0773)

[1] Standard deviations reported in parenthesis. In each estimation, a constant term was included to control for the fact that, given the small size of the two sub-samples, the average output gap is different from zero. [2] The sample used for the estimation is from July 1996 to December 2000.The set of instruments is: xt-2 to xt-12; Δqt-1 to Δqt-5; rt-2 to rt-7 and the change in the oil price Δopt-1 to Δopt-5. [3] The sample used for the estimation is from January 2001 to June 2006. The set of instruments is: xt-2 to xt-12; qt-1 to qt-19; rt-2 to rt-12 and the change in the oil price Δopt-1 to Δopt-15.

(iii) The parameters of the real exchange rate equation are calibrated to ensure that in the long run the real exchange rate is consistent with output at its long-term trend (zero output gap):

Table A3

RER equation

Sample	q_{t-1}	$E_t[q_{t+1}]+(r_t^{US} - r_t)$
1996–2000	0.401	0.592
2001–2006	0.315	0.677

(iv) The estimated Taylor type rules for the two sub-samples are as follows:

Table A4

Taylor rule[1]

Sample	$\pi_t^A - \pi_t^*$	x_t	i_{t-1}
1996–2000[2]	5.227	8.707	0.851
	(1.4422)	(2.8921)	(0.0699)
2001–2006[3]	1.086	1.556	0.807
	(0.5504)	(0.8365)	(0.0990)

[1] Standard deviations reported in parenthesis. In each estimation, a constant and a trend variable were included to control for the downward trend followed by the nominal interest rate as a result of the gradual reduction of inflation. [2] The sample used for the estimation is from July 1996 to December 2000. The set of instruments is: a constant; πt-1 to πt-3; qt to qt-3; it-2 to it-4; iUSt; π*t-1; and xt-1 to xt-5. [3] The sample used for the estimation is from January 2001 to August 2006. The set of instruments is: a constant; πt-1 to πt-5; Δet to Δet-5; π*t-2 to π*t-3; xt-1 to xt-4; it-2; iUSt; and xUSt-1 to xUSt-2.

(v) The CPI inflation is defined using the weights of the core and non-core price sub-indices on the CPI:

$$\pi_t \equiv 0.69\,\pi_t^c + 0.31\,\pi_t^{nc}$$

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