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Understanding the money–prices relationship under low and high inflation regimes: Argentina 1977–2006

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A B S T R A C T

We study the regime dependence of the money–prices relationship, focusing on Argentina's experience over the last 30 years. Using descriptive and cointegration analysis we find that proportionality holds for the high inflation period but weakens once inflation lowers. Money velocity correlates positively with money growth under high inflation, while this relation reverts under low inflation. VAR analysis allows to identify the key role of inflation expectations in driving the short-run dynamics of the money growth–inflation relationship under high inflation. Although this relationship weakens under low inflation, money continues to play a role in explaining inflation dynamics in Argentina.

1. Introduction

It is quite established in the literature that a strong positive correlation exists between money and prices in the long run (see Lucas, 1980; Dwyer and Hafer, 1988; Mc Candless and Weber, 1995) and that this relationship is close to proportional.

Recent empirical evidence from cross-country analysis, covering the last 30 years for a large set of countries (see De Grauwe and Polan, 2001) suggests, however, that the money growth–inflation relationship could be dependent on the country long-run level of inflation. It seems to be close to proportional for countries which have experienced high inflation, but weaker for low inflation economies.

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This literature implicitly assumes long-run values of inflation and money growth varying across countries but being invariant for a given economy, ignoring the potential dependence of this relationship on policy regimes. Here we adopt a different approach and study this relationship for a given country to investigate if it could be dependent on regime, defined as the institutional environment in which both, the public and the authorities form expectations, interact and make decisions (Heymann and Leijonhufvud, 1995).

With this aim, we adopt a time-series approach focusing on the Argentine economy. Argentina provides an excellent opportunity to study the regime dependence of the money growth–inflation relationship, since it went through dramatic regime changes: very high inflation in the 1970s and 1980s, hyperinflation in 1989 and 1990 and low inflation since then on.

The advantage of this approach compared to the cross-country analysis is that, since no country-specific effects that potentially influence the money growth–inflation relationship are present, the differences that might appear in this relationship can mostly be attributed to regime changes.

We study the regime dependence of the money growth–inflation relationship in Argentina between 1977 and 2006, from two different perspectives. The first one studies this dependence looking at the long-run relationship between these two variables using descriptive analysis and cointegration techniques which allow us to verify the relevance of some stylized facts quite established in the literature. From descriptive analysis, we find that although proportionality seems to hold when we consider the whole sample, the relationship between both variables is much less than proportional under low inflation. In line with this, cointegration analysis indicates the presence of a changing common trend between money and the price level along the sample period: Proportionality cannot be rejected for the high inflation period, but the long-run relationship between these two variables is much lower than one for the low inflation period. Our results using a time-series approach are consistent with the cross-country evidence (De Grauwe and Polan, 2001).

The second perspective focuses on the short-run relationship: Using VAR analysis and enlarging the data set to include variables which are relevant for the transmission of nominal shocks to inflation we find significantly different dynamics depending on the inflation regime. Impulse-responses show that under high inflation the inflation expectations component implicit in the nominal interest rates plays a key role in explaining the dynamics of money growth and inflation. On the contrary, under low inflation, nominal impulse-responses are more in line with the empirical regularities found in the literature.

The paper is organized as follows: Section 2 shortly revises the literature on money growth and inflation. Section 3 provides a brief description of the main money and inflation developments in Argentina over the last 30 years. Section 4 analyses the regime dependence of the money growth–inflation relationship from three different perspectives: their long-run relationship, their relationship with money demand and inflation expectations and their short-run dynamics. Finally, Section 5 concludes.

2. Money and prices in the literature: theory and empirical evidence

The relationship between money and prices or money growth and inflation has been largely studied in both, the theoretical and the empirical literature. From the long-run perspective some quite established stylized facts have been drawn. For example, persistently high inflation can be associated to persistent money growth. The interactions between those two variables in the short-run is, however, much more controversial. In fact, no stylized facts on this relationship have been established and accepted for high frequency data.

The theoretical literature provides two main explanations for persistently high inflation: (i) persistent government attempts to exploit the trade-off between output-gap and inflation, which can lead to dynamic inconsistency problems and (ii) recurrent monetary financing of fiscal disequilibria. The first one was the theoretical argument to explain the persistence of high inflation in developed countries during the 1970s and 1980s (see Kydland and Prescott, 1977). The second one was the theoretical argument initially developed by Cagan (1956) to explain hyperinflation in the 1920s. This argument was afterwards extended to explain high inflation and hyperinflation in some developing countries, like Argentina, Israel and Brazil where inflation was mainly due to monetary financing of fiscal disequilibria. Heymann and Leijonhufvud (1995) emphasize that in those cases, the limits between monetary and fiscal policy are not clear. The fiscal deficit can be treated as an exogenously

determined variable that explains money growth. In this context money growth can be considered as endogenous to the fiscal deficit and even to the inflation rate.

With respect to the long-run relationship between money growth and inflation in the empirical literature, Lucas (1980), Dwyer and Hafer (1988) and Mc Candless and Weber (1995) find for different groups of countries a strong positive correlation and proportionality between money growth and inflation in the long run after discarding the high frequency component of both time series.

More recently, De Grauwe and Polan (2001) look at a panel of 160 countries over 30 years (1969–1999) and find that the degree of co-movement between money growth and inflation depends on mean inflation. In countries having experienced high inflation and hyperinflation, the correlation between money growth and inflation is strong, while this relationship weakens in low inflation countries. They also find that money growth and velocity are positively correlated in high inflation countries, suggesting the validity of a Cagan's money demand, while the opposite occurs in low inflation countries.

Marcet and Nicolini (2005) emphasize the difficulty of nesting both empirical findings in a comprehensive monetary theory, since rational expectation monetary models, with flexible prices, predict a strong positive correlation between money growth and inflation. To deal with this inconsistency two monetary theories have been developed: one describes a world of high inflation under rational expectations. The other tries to resemble the empirical correlations observed for low inflation countries by assuming some kind of price rigidity. They find this solution quite imperfect, not only for theoretical reasons but also because of the policy recommendations coming from those two theories of inflation: while in a world of high inflation there is a crucial role of money growth in driving inflation dynamics, money could become irrelevant in a world of low inflation. In fact, this is the most common view adopted in macro modeling for policy purpose under the New-Keynesian framework.

From the short-run perspective, the channels through which money can affect the prices are multiple and dependent on the monetary regime. Changes in monetary aggregates reflect both the response of the central bank and private agents to different shocks that can affect the economy. Given the endogenous nature of monetary policy, VAR models appear to be the most adequate tool to study the transmission of nominal shocks to the economy in the short-run, and they have been extensively used in developed economies with mixed results.[1] Much less is the empirical evidence for developing countries, although in recent years, the movement towards floating exchange rate regimes and a consequently more active role of monetary policy in these countries has stimulated the study of the transmission of nominal shocks to the economy for monetary policy conducting purpose.

Argentina is an interesting case to study the regime dependence of the money growth–inflation relationship, since it has experienced a dramatic regime changes. During the 1970s and 1980s, the economy went through a very high inflation, ending in a hyperinflation in 1989 and 1990 and a subsequent period of low inflation from 1991 to 2006.

Previous work by Gabrielli et al. (2004) tried to extract some lessons on the money growth–inflation relationship in Argentina during the periods 1976–1989 and 1991–2001 using descriptive and bivariate VAR analysis. They find that under high inflation, inflation leads money growth, while the opposite occurs under low inflation.

We extend their work in several dimensions. First, we evaluate the regime dependence of the long-run relationship between money and prices using cointegration analysis. Second we study the behavior of money velocity and its relationship with money growth and inflation, with the aim of incorporating money demand and inflation expectations behavior into the analysis. Third, using multivariate VAR analysis we look at the short-run dynamics of money growth and inflation in a multivariate context and investigate if there are changes in the transmission of nominal shocks to inflation depending on regime.

3. A brief review of Argentina's monetary history 1977–2006

In this section we briefly revise the main monetary developments over the last 30 years in Argentina, with the aim of providing a framework to our empirical findings. This review suggests that the observed breaks in inflation cannot be attributed to the adoption of a particular monetary/

[1] See Sims (1992). For an excellent review of the literature on this topic see Christiano et al. (1999).

exchange scheme, but rather to the soundness and strength of monetary and fiscal policies and institutions so as to make fiscal and monetary policy inter-temporal and mutually consistent, contributing to avoid fiscal dominance problems.[2] From this perspective, regimes should not be only classified according to a particular monetary or exchange rate scheme, but also to the institutional framework under which monetary and fiscal policy interact and are made (or not) consistent.

These regimes could presumably influence both, government and private sector expectations formation and interactions and by these means be determinant for the money–prices relationship. Since the inflation rate that prevails in the economy for a period of time is, in our view, the most satisfactory variable that summarizes these interactions we use it as a criterion to identify regimes. Following it, we identify two inflation regimes: High inflation between 1977 and 1990 and low inflation from 1991 to 2006 (see Fig. 1).

During the 1970s and 1980s inflation remained on average at very high levels, ending in two hyperinflation episodes in 1989 and 1990. While repeated attempts by governments to stabilize inflation through the adoption of different monetary-exchange rate schemes and economics reforms, a common institutional feature that remained unchanged over this process was fiscal dominance, facilitated by weak monetary institutions, which allowed the central bank to monetary finance the government by different means.

In 1991, the adoption of a hard peg by law, known as the Convertibility plan, appears as a clear breakpoint in the inflationary history of the country, leading to a dramatic and permanent drop in inflation. This scheme was accompanied by a broad economic reform in order to make it credible. The Central Bank chart was reformed, imposing severe restrictions to monetary financing of fiscal deficits and indexation practices were forbidden. Additionally, a public sector reform was implemented, which helped to significantly reduce fiscal imbalances. The strengthening of monetary and fiscal institutions along with the improvement in fiscal performance helped to reduce fiscal dominance. This scheme ended in an economic and financial crisis in 2001, leading the peso to a sharp depreciation of 250% along 2002. Contrary to expectations based on the previous inflationary history of Argentina, the sharp depreciation of the peso did not imply a structural break in terms of the trend inflation, probably due to the fact that strengthening of the monetary institutions was not reversed and government fiscal accounts remained quite healthy.

It can be seen from Fig. 1, that inflation in Argentina had been high and persistent since the mid seventies, rooted in important fiscal imbalances and weak monetary institutions that facilitated government financing through the inflation tax. In 1973 a reform of the Central Bank virtually nationalized bank deposits imposing 100% reserve requirements, allowing it to give rediscounts to public banks to fund subsidized credit to specific sectors and to monetize provincial government's deficit.

The outburst of an inflationary episode in 1975, following a period of widespread government price controls, led to subsequent accelerating spiral of prices and wages, which produced a breakpoint in the macroeconomic performance of the economy, initiating a period of very high inflation. Indexation practices in contracts extended, adding persistence to inflation.

The military government that took office through a coupe in 1976 followed an exchange rate stabilization to deal with inflation that had reached 770% annually by 1976. Following a wave of market oriented policies in the region, financial and trade liberalization reforms were implemented. The government announced its compromise to reduce the fiscal deficit but in fact partially replaced monetary by external capital markets financing. As part of the financial reform, the Central Bank chart was again modified in 1977, partially reverting the nationalization of deposits established in 1973. The Central Bank introduced a complex reserve requirement scheme including the remuneration on time deposits, creating a *quasi-fiscal* deficit that grew steadily, increasing consolidated public sector debt and thus creating additional sources of money creation (Di Tella and Dornbusch, 1989).[3]

[2] On the issue fiscal dominance in the literature see: Sargent and Wallace (1981), Woodford (2001) and Walsh (2003).

[3] Reserve requirements were reduced and, as a way to collect the inflation tax, charges were imposed on loanable funds associated to sight deposits, for which reserve requirements remained relatively high compared to time deposits. At the same time, the Central Bank remunerated banks reserve requirements on time deposits, compensating banks for loss in the real value of immobilized funds due to inflation. For a detailed description of this mechanism see Castagnino (2005).

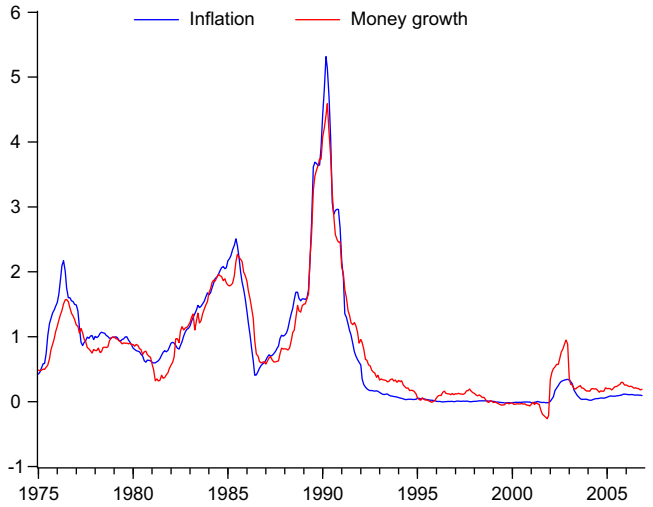

Fig. 1. Annual money growth and inflation (1977–2006).

While the policies adopted were initially successful in reducing inflation to 150% annually in 1977, the fact that inflation seemed to have reached a floor, pushed economic authorities to adopt a crawling peg to the dollar (*tablita*) in 1979 with the aim of making inflation expectations converge to nominal devaluation. Combined with a monetary tightening, this exchange rate scheme led to further reduction in inflation, but did not avoid a sharp appreciation of the real exchange rate (De Pablo and Dornbusch, 1989).

By 1980 the currency was significantly overvalued. With the economy running persistent current account deficits, both public and private sector debt's had been increasing dramatically. Markets started to discount a sharp depreciation of the currency, leading to a reversal in capital flows. In 1982, the dramatic jump in world interest rates led to an external and financial crisis in several countries in the region, including Argentina. The peso depreciated sharply and part of the private sector's external debt was absorbed by the government, amplifying the debt burden. Inflation accelerated significantly in the following years in spite of some efforts to reduce the fiscal deficit.

After the failure of these liberalizing reforms, the new democratic government that took office in 1983, introduced subsequent stabilization plans with more heterodox elements in the context of a more regulated economy with some features of financial repression,[4] and high tariffs and non-tariff trade barriers. But the main sources of money expansion and inflation dynamics remained unchanged: structural fiscal disequilibrium and weak monetary institutions.

Between 1981 and 1985, inflation accelerated significantly fueled by both, the monetary financing of a worsening fiscal imbalance and the deepening of the currency substitution phenomenon.[5] The fiscal disequilibrium widened with the increasing burden of external debt services and the deterioration in real tax revenues due to inflation.[6] A vicious circle of monetary financing of fiscal deficits, subsequent exchange rate depreciation, increases of external debt services and accelerations in money velocity developed. The flight from the domestic currency due to increasing inflation expectations was at that time the main force driving the dynamics of money and prices. Indexation practices spread out, adding persistence to inflation and fueling expectations.

[4] An expression coined by McKinonn and Shaw to refer to the restrictions to the financial sector.

[5] The phenomenon of flight to a reserve currency, the dollar, reflected the low confidence on the domestic currency, yielding to an unstable money demand governed by inflation expectations. It was a defensive mechanism of economic agents to protect their wealth in periods of high macroeconomic instability.

[6] The Olivera Tanzi effect related to the lags in tax collection.

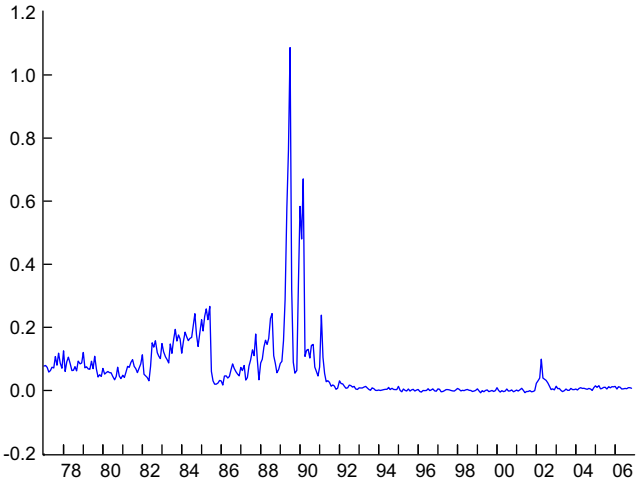

Fig. 2. Monthly inflation (1977–2006).

In June 1985, after several unsuccessful attempts at stabilizing the economy, annual inflation reached a peak of 1500% annual, leading the economy close to a hyperinflation. The government announced a stabilization plan known as the *Plan Austral*. The plan aimed at restoring the public's confidence on the domestic currency by anchoring inflation expectations and freezing relevant prices of the economy.[7] Joint with a depreciation of the currency and significant increases in public-owned utilities tariffs, duties on exports and import tariffs, and the freezing of wages and some other key prices were announced. A new currency called *Austral* was adopted, together with the announcement of a halt to monetary financing of fiscal deficits and new agreements with the IMF and key borrowers. Inflation plunged to less than 2% monthly, and fiscal accounts improved. This rapid enhancement of fiscal accounts gave credibility to the promise of non-monetary financing (Damill et al., 1989).

But the intention to control relative prices failed once inflationary pressures in certain sectors, in which prices were not regulated, persisted. The freezing of tariffs contributed to keep inflation stable in the short-run but increased the fiscal deficit, since utilities were public-owned at that time. At the beginning of 1986, the government allowed for a more flexible adjustment of the exchange rate and tariffs. This, in turn, made the government more vulnerable to social demands. Wage negotiations went further than the announced targets and inflation reaccelerated by the end of 1986 leading to a deterioration of the fiscal position of the government. By mid 1989, after several failed attempts to control inflation by freezing prices and wages, a hyperinflationary process unchained reaching a peak of 5000% annually.

In April 1991 a currency board scheme, the convertibility, was adopted in an attempt to anchor inflation expectations by fixing the peso to the dollar by law. The new institutional framework also included the suppression of any kind of contract indexation and an explicit forbiddance of central bank financing to the government.

The adoption of this scheme was accompanied by economic reforms aiming at solving the structural fiscal disequilibrium and improving competition. A public sector reform, including the privatization of the main public enterprises and a tax reform to amplify the tax base, was introduced. As part of a deregulation process many subsidies to the private sector were eliminated, the capital account was liberalized and import tariffs were significantly reduced. Privatizations combined with rapid private consumption, investment contributed to equilibrate fiscal accounts.

[7] See Gerchunoff and Llach (2005) for a detailed description of the Plan Austral.

At the same time a financial reform was introduced. Banks were allowed to issue dollar-denominated deposits and loans in order to foster financial depth, given the lack of confidence in the domestic currency. Strong prudential regulations, in line with international Basel standards were also introduced with the aim of avoiding the financial fragility problems created by previous financial liberalization reforms.[8] The hard peg joint with the financial reform helped deepening the financial system and extending the duration of contracts. While not visible at the beginning of the plan, the financial reform, by allowing the dollarization of banks' portfolio, created a solvency risk for the financial system in case the hard peg had to be abandoned, since bank debtors, whose income was peso denominated, would become insolvent Barajas et al. (2007). Money demand and time deposits increased persistently revealing a dramatic reversal in agent's expectations. The convertibility scheme and the accompanying economic reforms succeeded in anchoring inflation expectations and bringing down inflation, converging to low levels by 1993.

Although during almost all the first part of the decade the economy grew steadily,[9] it experienced persistent current account deficits as the hard peg to the dollar led to a significant real appreciation of the currency. With the financing of fiscal deficit almost exclusively relaying on international capital markets due to the restrictions imposed by the convertibility scheme, the lack of depth of domestic financial markets, and a fiscal reform that remained quite incomplete, the public debt was quite vulnerable to sudden reversals in international markets financing. Both, the public and private sector's external debt grew steadily over these years, but it was not until several external shocks[10] hit the Argentine economy that the inconsistencies and rigidities of the convertibility scheme clearly emerged.

In 1998 the economy entered a deep and prolonged recession. Increases in international interest rates led to a higher burden of interest payments in the fiscal accounts, while at the same time tax revenues decreased due to the recession. The government and the private sector's external debt increased over time and began to be perceived as unsustainable. With the peso highly appreciated, the Brazilian devaluation of January 1999 led to a deepening of the recession. The government began to lose access to international capital markets and had to rely more heavily on domestic banks and pension fund financing, increasing the solvency risk of the domestic financial system.

By the end of 2000, the government suffered a political crisis and a financial crisis unchained. Few months later, after a sharp rise in country risk, Argentina was out of global capital markets because of the uncertainty about its fiscal solvency. The fiscal accounts fragility became more evident once the economy entered a severe and prolonged recession. The real appreciation of the peso combined with the recession and high unemployment put strong deflationary pressures on the economy, worsening the fiscal situation and creating social unrest. The only financing sources left were domestic banks, the privatized pension system and the international financial institutions (IFIs). The IMF forced the government to cut fiscal expenditures. Fears of a sharp depreciation reinforced uncertainty, stopping inversion, stimulating capital outflows and leading to a fall in international reserves and deposits and, consequently, to a downturn in economic activity. In December 2001 the government decided to freeze deposits at the banking system, suspend the convertibility of the peso and declare the cessation of debt payments service.

The financial crisis led to a political crisis, forcing a transitory government to assume. In February 2002, a new government with stronger political support took office. The peso was devalued by 40%. Banks' balance sheets were asymmetrically "pesified" by converting dollar-denominated deposits at an exchange rate of 1.4 and dollar-denominated loans at par. After suffering a strong market pressure, the government let the peso float.

The economy plunged 11% year over year in the first quarter of 2002. The means of payment were severe damaged. The Central Bank had to inject liquidity in banks to support them in the middle of a financial turmoil, fulfilling the pressure on the peso, which depreciated 250% in April 2002. In

[8] See in this respect Díaz-Alejandro (1985).

[9] In 1995, despite the economy experienced four years of strong growth and the presumably high confidence of international investors, an external shock, the Tequila crisis, led to a bank run. The government succeeded in managing the crisis and the economy recovered quite rapidly, but the episode made clear that the economy could suffer a speculative attack.

[10] The Asian crisis in 1997, the Russian crisis in 1998 and the Brazilian devaluation of 1999.

November 2002, inflation reached a peak of 41%, but the government was successful in avoiding hyperinflation because of both, tight monetary and fiscal policies (the public sector's wages were frozen) and the rapid re-creation of instruments in pesos offering central bank notes at high interest rates. The two first brought the spiral between prices and salaries to a halt, and the second, helped the peso to stop depreciating. In fact, inflation remained at relatively low/moderate levels. Low capacity utilization and high unemployment contributed to a low pass-through of nominal currency depreciation to domestic prices.

As soon as the exchange market and the financial system stabilized, the economy recovered rapidly due to the change in relative prices. Net exports grew rapidly, driven by the increase of the real exchange rate and the terms of trade. Current account surpluses combined with the easing of capital outflows improved the liquidity of the financial system and the economy as a whole allowing the Central Bank to rebuild its international reserves at the end of 2002.

The economy grew steadily over these years until 2006. The Central Bank implemented a monetary aggregates targeting, based on a partial sterilization of its reserve accumulation policy through the issuance of central bank notes to manage liquidity. Combined with a prudent fiscal policy this monetary arrangement succeeded in maintaining inflation at relatively low levels until 2006. What probably lies in part behind this success is the fact that the strengthening of the monetary institutions was not reversed in terms of relaxing the restrictions for the Central Bank to finance the government and the fact that the government followed sound fiscal policies.

4. The regime dependence of the money growth–inflation relationship: empirical analysis

Adopting a time-series approach, we empirically study the regime dependence of the money growth–inflation relationship in Argentina between 1977 and 2006. Based on the trend inflation as a criterion to identify regimes (as described in Section 3), we split our sample considering two regimes: (i) a period of high inflation from 1977 to 1988, over which several monetary/exchange rate schemes were adopted; and a (ii) low inflation period between 1993 and 2006, in which two different monetary schemes were in force: a currency board scheme and a monetary targeting under a managed floating scheme since January 2002 (see Fig. 2).[11,12]

We begin by investigating the presence of changes in the long-run relationship between money and prices using descriptive and cointegration analysis. Then, we look at the money velocity to evaluate if the behavior of money demand and inflation expectations changed along with shifts in the trend inflation. Finally, in section 4.3, we use multivariate VAR analysis to check for the presence of changes in the short-run dynamics of money growth and inflation depending on the inflation regime.

4.1. The long-run relationship between money and prices

In this section we concentrate on the long-run relationship between money and prices. Our purpose is to evaluate the long-run proportionality hypothesis, quite established in the literature, for the Argentine data. We also want to investigate to what extent the strength of the comovement between both variables depends on the inflation regime. We begin by using the classical approach, looking at the correlation between both variables for low frequency data. Then, we conduct cointegration analysis to investigate the presence of a unique common trend for the whole sample and long-run proportionality.

Lucas (1980), Dwyer and Hafer (1988) and Mc Candless and Weber (1995) find evidence that a strong positive correlation exists between money and prices in the long run and that this relationship is close to proportional. These studies were conducted for a significant group of countries and would corroborate one for one correspondence between money growth and inflation, one of the propositions

[11] We do not consider in this analysis the two hyperinflation episodes 1989 and 1990 because both were temporary phenomena.

[12] Studying inflation persistence, D'Amato et al. (2007), identify changes in mean inflation for Argentina using the Bai-Perron test. They identify a break in May 1989, during the hyperinflation period.

of the Quantity Theory of Money. De Grauwe and Polan (2001) find, from cross-country analysis over the last 30 years, that, although there is long-run positive correlation between money growth and inflation, proportionality does not hold for low inflation countries.[13]

For the Argentine case, Gabrielli et al. obtain a high positive correlation between money and prices. Using Granger causality tests, they also find that, prices lead money for 1976–1989 period while money precedes prices for 1991–2001 period.

Inflation is measured by the log of CPI index and money by the log of private sector holdings of M1 (currency plus current account deposits) seasonally adjusted.[14] We are interested in transactional money holdings by the private sector.

As mentioned before, the international evidence confirms strong positive co-movement between money growth (μ) and inflation (π) in the long run. Lucas (1980) finds a relation close to one between both series after filtering to get rid of the noise present in high frequency data. Mc Candless and Weber (1995) study the long-run relation between inflation and money growth rates and for a significant group of countries. Their results also confirm a positive co-movement between both series.

We first calculate correlations between μ and π for high frequency data (monthly changes). The correlation between μ and π is strong and significant for the whole sample. When we split the sample, the two series strongly commove for the high inflation period (see Appendix 1). On the contrary, during the low inflation period the relationship between them weakens.

Considering low frequency data (annual changes), the correlation between μ and π increases on average. Under the low inflation period, the correlation between both series increases from 0.13 for monthly changes to 0.68 for annual changes. Therefore, inflation and money growth have a significant positive correlation in the long run. Once we remove the noise present in high frequency the correlation between money growth and inflation increases significantly, even for the low inflation period.

During the high inflation period, cross-plots between μ and π converge to the 45° slope, in line with Lucas (1980) (see Fig. 3). In contrast, in the low inflation regime, in spite of the increase in correlations using low frequency data, proportionality does not hold. These results contradict the proportionality proposition of the Quantity Theory of Money and are consistent with recent empirical evidence for low inflation countries (see De Grauwey and Polan, 2001). If we consider the 2002–2006 period, over which a managed floating scheme was in force, it seems that the adoption of a more active monetary policy did not reflect in a strengthening of the correlation between money growth and inflation.

The finding of similar money growth and inflation rates for the whole sample suggests that there could be a common long-run trend between money and prices (see Fig. 4).

We conducted cointegration analysis using the system-based procedure of Johansen (1988) and Johansen and Juselius (1990). The Vector Error Correction Mechanism allows us testing the validity of the conditional models through the "weak exogeneity tests".

The starting point to evaluate cointegration is to analyze the time-series properties of the variables. We evaluate the order of integration of both time series using the Augmented Dickey–Fuller (ADF) test, a standard unit-root test; the Phillips–Perron (PP) and other versions of Dickey–Fuller recursive and rolling which allow evaluating changes in mean and trend. The conventional tests (ADF and PP) indicate that we can't reject the null of the presence of a unit root in M1 and the CPI (both measured in logs). However, the results of the other Dickey–Fuller versions are not conclusive about the order of integration of both time series.[15]

Given that not only economic theory but also the empirical literature are in favor of its treatment as stationary in differences, we considered money and prices as integrated of order 1, I(1). The cointegration analysis was made using quarterly data. When splitting the sample in sub-periods, we discarded the disinflation period from the second quarter of 1991 to the fourth quarter of 1992.

[13] See Mc Candless and Weber (1995), Dwyer and Hafer (1999) and De Grauwe and Polan (2001).

[14] We choose this definition of money because we are interested in transactional money holdings by the private sector. M1 is the most homogeneous aggregate along the full sample considered here and corresponds to end of period holdings, since average data are not available for the whole period of analysis.

[15] Appendix 1 presents an exhaustive analysis of these results.

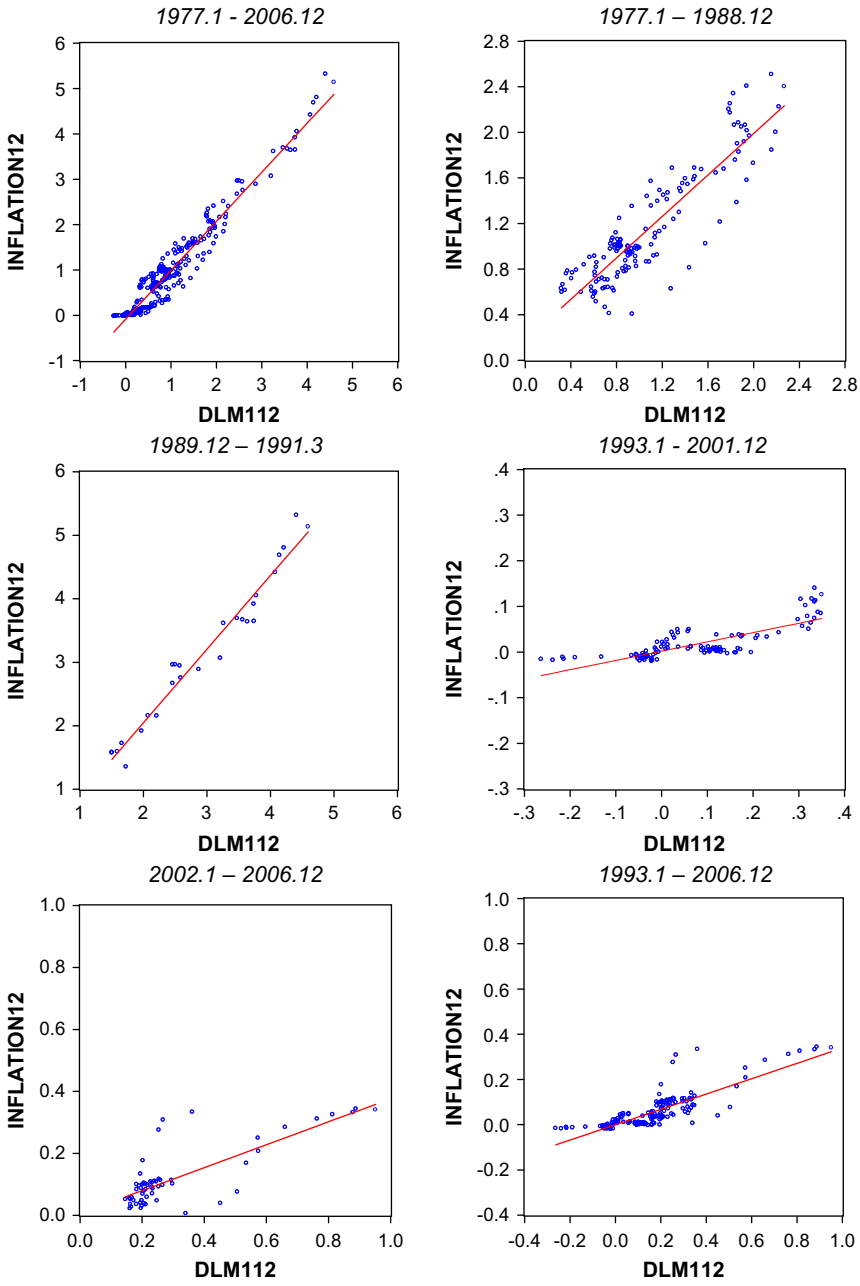

Fig. 3. Money growth and inflation (annual change).

The system-based procedure of Johansen (1988) and Johansen and Juselius (1990) indicates the presence of a positive long-run relationship between money and prices for the complete sample except for the hyperinflation period, although with long-run coefficients changing between the two inflation regimes. The relationship is quite stable until 1988: An increase in money generates a proportional

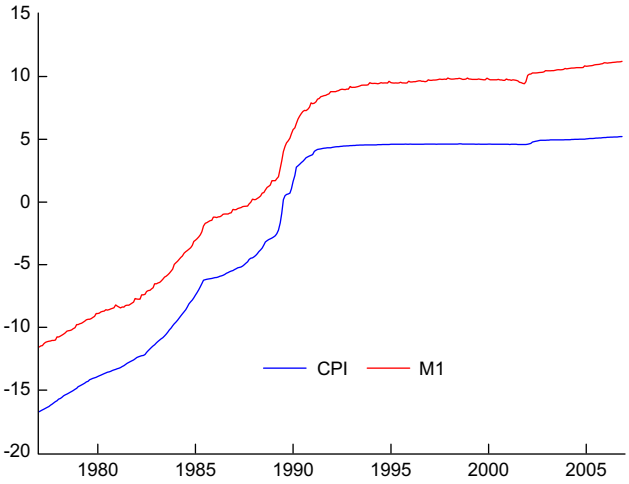

Fig. 4. Money and consumer price index (in logs) (1977–2006).

change in prices in the long run. Since the adoption of the convertibility regime, the long-run impact of money on prices is much less than one (0.17) and the long-run effect increases since the abandonment of this regime to 0.30. If the whole sample is considered, it is not possible to find a long-run stable relationship. This finding validates the prior of different behaviors during high and low inflation regimes. Exogeneity tests indicate that money is weakly exogenous, validating a conditional model of prices on money (see Table 1).

These results confirm that the long-run relationship between money and prices depends on the level of inflation and validate the rejection of the proportionality prediction of the Quantity Theory of Money for Argentina under low inflation. In particular, we can identify two regimes, according to cointegration analysis. Proportionality holds in the long run between money and prices under the period of high inflation but their relationship weakens during low inflation.

4.2. Inflation and velocity

Looking at money velocity through the quantity equation could be informative about the dependence of money demand and inflation expectations on regime. Monetary theory suggests that high long-run money growth is consistent with high inflation, a low real money demand (i.e. high money velocity). According to the Quantity Theory, money has a transactional role and real balances should keep a stable relationship with aggregate transactions. This ratio is money velocity, which is assumed to be relatively stable in the short-run, since it depends on financial technologies, agents' preferences, or institutions that are supposed to remain quite stable in a short horizon.

The empirical evidence suggests, however, that money velocity is in general volatile, contradicting the assumption of a stable money demand. In high inflation regimes, under which the inflationary tax is usually a significant source of tax revenues, inflationary expectations are an important determinant

Table 1
Money and prices: long-run relationship and exogeneity.

Period	Cointegration	Exogeneity	Equilibrium correction term
1977–2006	No		
1977–1988	Yes	Money	$Dlcpi_t = -0.14\ [lcpi_{t-1} - 1.03\ lm1_{t-1}]$
1989–1991	No		
1993–2001	Yes	Money	$Dlcpi_t = -0.49\ [lcpi_{t-1} - 0.17\ lm1_{t-1}]$
1993–2006	Yes	Money	$Dlcpi_t = -0.40\ [lcpi_{t-1} - 0.28\ lm1_{t-1}]$
2002–2006	Yes	Money	$Dlcpi_t = -0.45\ [lcpi_{t-1} - 0.30\ lm1_{t-1}]$

of real money demand. Money growth accelerations, through their effects on inflationary expectations lead the public to get rid off their real money holdings. Consequently, increases in money velocity feed inflationary dynamics. In these economies it is usual to observe that both, accelerations of inflation and stabilizations have significant effects on money velocity.

With the purpose of investigating the dynamics of money velocity and its relationship with money growth and inflation we calculate it according to the quantity equation:

$$M * V = P * Q$$

where M is money in nominal terms, V is money velocity, P is the price level and Q is real output. So, velocity can be calculated as:

$$V = (P * Q)/M$$

Using nominal output, we calculate money velocity for M1 over the period 1977–2006 (in a quarterly basis).

Fig. 5 shows that M1 velocity is highly volatile but exhibits a positive trend from 1977 to 1990, and a negative one between 1991 and 2006. Additionally, we verify that velocity is positively correlated with inflation for the full sample (the correlation between this two variables is 0.79).

During most of the seventies and eighties inflation accelerated. After the sharp reduction in inflation that followed the set up of the convertibility regime, velocity exhibits a persistently negative trend. Since the 2001 financial crisis, this negative trend continued, despite an acceleration of inflation in 2005 (see Fig. 5).

We analyze the relationship between velocity, money growth (μ) and inflation (π) for the high inflation period (1977–1988) and the low inflation period (1993–2006). From Table 2 it can be seen that for the high inflation period, an acceleration of μ is related to a rise in inflation and velocity. During this period, the correlations between velocity and π, and velocity and μ are 0.81 and 0.62, respectively. This increase of money velocity is consistent with Cagan's (1956) and Sargent's et al. (2006) findings for high inflation countries that inflation accelerations may be driven by inflation expectations that led agents to reduce their real demand for money.

On the contrary, under low inflation, velocity is negatively correlated to π and μ. In particular, during this period, the correlation between velocity and π is -0.23, and between velocity and μ is -0.33 (Fig. 5).

Our results for the low inflation period are consistent with the cross country findings of De Grauwe and Polan for low inflation economies that indicate a negative correlation between money growth and velocity. They also suggest that in the case of low inflation economies, the negative correlation between

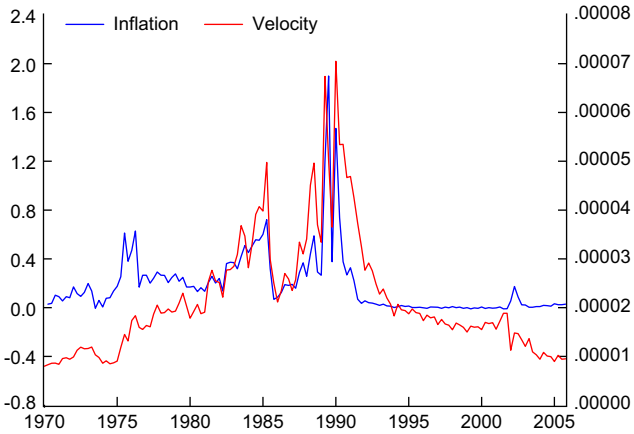

Fig. 5. Inflation and money velocity (1970–2006).

Table 2
Correlation between money velocity (V) and inflation (π), and Money velocity and money growth (μ).

Correlation	1977Q1–2006Q4	1977Q1–1988Q1	1989Q1–1991Q1	1993Q1–2006Q4
$\boldsymbol{V}-\pi$	0.7943	0.8136	0.6221	−0.2374
$\boldsymbol{V}-\mu$	0.7546	0.6215	0.3843	−0.3342

Note: μ is quarterly change of M1 seasonal adjusted, π is quarterly change of CPI.

velocity and μ could be explained by the liquidity effect: Increases in money growth lead to a decrease in interest rates, which also lead to a rise in money demand (i.e. a decrease in velocity).

In economies subject to high macroeconomic volatility, as it is the case of Argentina, successful macroeconomic stabilization polices usually lead to a remonetization of the economy. We observe this empirical regularity after the *Plan Austral*, the set up of the convertibility regime and the aftermath of 2001–2002 financial crisis.

To sum up, we find that money velocity dynamics is dependent on the inflation regime. Under high inflation, money velocity is positively correlated with money growth and inflation, capturing Cagan's findings that inflation accelerations may be driven by inflation expectations that led agents to reduce their demand for money. Under low inflation, our results are consistent with the findings of De Grauwe and Polan for low inflation economies that indicate a negative correlation between money growth and velocity that in the case of Argentina could be explained by successful macroeconomic stabilization polices which induce to a remonetization of the economy.

4.3. The short-run dynamics of money growth and inflation

The short-run relationship between money growth and inflation is still quite more controversial and, in spite of the large amount of literature devoted to the issue, it has not been possible yet to draw any stylized facts on it (Dwyer and Hafer, 1988). To study it, we enlarge our variables set to include other relevant macroeconomic aggregates and prices that play a relevant role in the transmission of nominal shocks to inflation: the nominal interest rate, GDP growth and the change in the nominal exchange rate.

We estimate Vector Autoregressive Models (VAR) for these variables, following the methodology originally proposed by Sims (1980). VAR analysis provides two useful tools to study short-run dynamics: impulse-response functions and variance decomposition.

To identify shocks we impose the following ordering for the Cholesky decomposition. The nominal interest rate was put first, assuming that it is highly probable that this variable can have a contemporaneous effect on the other variables in the system, while the opposite is much less probable. The interest rate is then followed by money growth, the change in the multilateral nominal exchange rate, the GDP growth and lastly, the inflation rate.[16]

Interest rate shocks (impulses) are not necessarily interpreted here as monetary policy shocks. During the high inflation period they can probably reflect inflation expectations shocks, which in this context could even drive the interest rate dynamics (as in Cagan, 1956). Under the convertibility regime there was no active monetary policy, so movements on interest rates in the domestic currency mainly reflected changes in international interest rates and sovereign risk perceptions. Finally, during the managed floating period, a monetary targeting strategy was adopted.

We estimated VAR models for the whole sample as well as for the high inflation period (1977–1988), and the low inflation period (1993–2006). We also consider the convertibility period (1991–2001) separately in order to identify changes in the joint short-run dynamics of variables after the abandonment of the hard peg by comparing results with the complete low inflation period. As in the

[16] This ordering assumes no contemporaneous effects of financial variables as money and the nominal exchange rate on the nominal interest rate, what is quite plausible for monthly data, but can be under question for quarterly data, which is the case here.

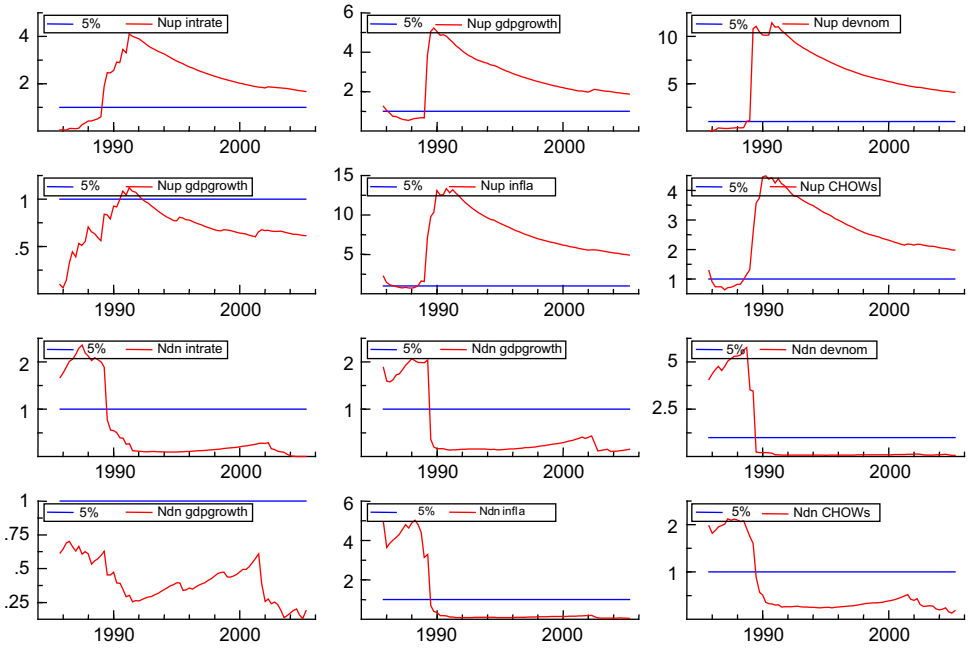

Fig. 6. Parameter stability.

previous section, we discard the hyperinflation (1989 and 1990) and the disinflation period (1991–1992).

Models were estimated for quarterly data which include the following variables: the nominal interest rate on time deposits (intrate), money growth (Mgrowth), the real GDP growth (GDPgrowth), the change in the multilateral nominal exchange rate with the main trade partners[17] (nomdev) and the CPI inflation (infla).

VAR models are specified in differences, since our interest in this section is to study short-run dynamics. This treatment is supported by unit-root tests, which are in general in favor of the hypothesis of unit roots for all variables, except the nominal interest rate.[18,19] Variables were specified in natural logs differences, except for the interest rate, which was expressed in levels.

As expected, when considering the whole sample (1977Q1–2006Q4) we are not able to obtain a model that satisfies the conventional criteria. In particular, models are highly heteroskedastic, indicating a changing volatility in the joint dynamics of the variables under study, what suggests the presence of structural breaks. Recursive analysis using Chow Break-point tests (N descendent) and Forecast (N ascendent) to test for parameters stability, reveal the presence of one structural break in the hyperinflation period (see Fig. 6). This evidence supports our splitting of the sample into two periods, high and low inflation based on the trend inflation.

The presence of a structural break at the hyperinflation period restricts the possibility of estimating a model for the complete period using conventional estimation techniques. More sophisticated instruments, as varying coefficient models have to be used to address the problem. Our approach to the

[17] Brazil, US and EU.

[18] The presence of a unit root for the variables in the VAR system was evaluated running conventional augmented Dickey–Fuller and Phillips–Perron tests as well as sequential and rolling test to check for the presence of structural breaks in the mean or the slope of time series. See Appendix 1.

[19] The models were selected according to the standard criteria of normality, non autocorrelation and homoskedasticity. We also checked the stability of VAR models. Dummy variables were incorporated when necessary to control for outliers. The lag-structure was selected based on Akaike, Schwarz and Hannan-Quinn criteria.

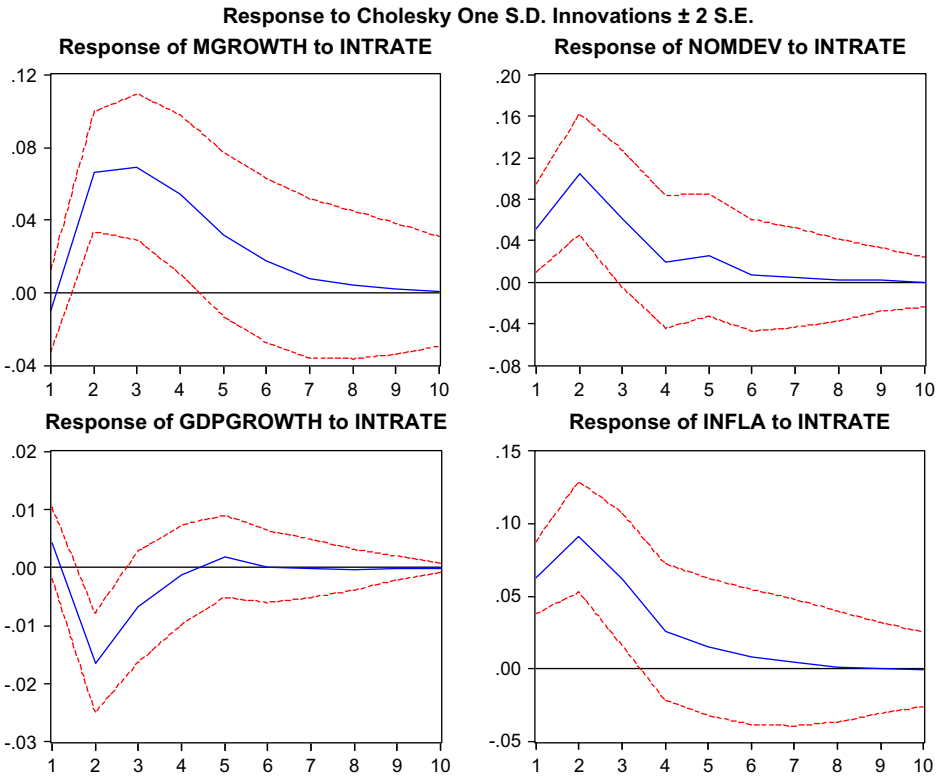

Fig. 7. VAR model 1977Q1–1988Q4 impulse-response functions.

problem here is rather simple. We split the sample in high and low inflation in order to study the dependence of the relationship between money and prices on the inflation regime. We also check for the presence of changes in the transmission of nominal shocks to inflation after the abandoning of the convertibility, even though the results of the Chow breakpoint tests do not detect a structural break associated to the change in the monetary scheme in 2002.

We test and validate that our Cholesky ordering does not affect significantly the results conducting generalized impulse-response functions (as proposed by Pesaran and Shin, 1998).

(i) *Short-run dynamics under high inflation* (1977–1988)

Results of estimating a VAR model for this period are summarized in Fig. 7 and Table 3 that show impulse-response functions and variance decomposition respectively.

Looking at impulse-response functions, a first striking result is the positive response of changes in money growth to changes in the interest rate. A plausible interpretation of this result is that under a regime of high inflation, as it was the case of Argentina during part of the 1970s and 1980s, money demand was mainly driven by inflation expectations, which were possibly the main component governing the dynamics of the nominal interest rate. In this context, movements in the interest rate cannot be interpreted as the result of policy actions. On the contrary, they would rather reflect changes in inflation expectations. Thus a possible dynamics could be one in which increasing inflation expectations led to a reduction in money holdings by the private sector followed by a response of the central bank increasing money supply.

Another non-standard result is that shocks to the nominal interest rate have a positive effect on nominal depreciation. But again, under high inflation shocks to the nominal interest rate may essentially

Table 3
VAR model 1977Q1–1988Q4 variance decomposition.

Quarter	INTRATE	MGROWTH	NOMDEV	GDPGROWTH	INFLA
Responses to nominal interest rate shocks (INTRATE shocks)					
1	100.00	1.68	12.38	4.17	43.20
2	93.22	33.10	33.77	31.81	63.67
3	90.73	47.56	34.93	33.17	66.37
4	88.75	51.71	34.87	32.75	64.16
5	86.87	51.43	35.08	32.84	61.54
6	85.36	50.12	34.66	32.79	59.67
7	84.29	48.85	34.42	32.77	58.62
8	83.63	48.03	34.24	32.78	58.02
9	83.24	47.56	34.16	32.78	57.70
10	83.02	47.31	34.11	32.78	57.53
Cholesky ordering: INTRATE MGROWTH NOMDEV GDPGROWTH INFLA					
Variance decomposition of INFLA					
1	43.20	21.75	7.98	0.15	26.92
2	63.67	16.67	5.76	0.85	13.05
3	66.37	13.82	7.50	1.69	10.62
4	64.16	15.45	8.64	1.69	10.06
5	61.54	17.73	9.46	1.61	9.66
6	59.67	19.42	9.98	1.59	9.34
7	58.62	20.14	10.43	1.63	9.17
8	58.02	20.54	10.70	1.68	9.07
9	57.70	20.73	10.85	1.70	9.02
10	57.53	20.83	10.92	1.72	9.00
Cholesky ordering: INTRATE MGROWTH NOMDEV GDPGROWTH INFLA					

reflect shocks to inflation expectations. Therefore, as the currency substitution became an extended phenomenon, higher inflation expectations induced a flight from the domestic currency to a reserve currency as the dollar, leading to a nominal depreciation. This result is consistent with the finding in Section 4.2 of a positive correlation between money growth and velocity during the high inflation regime.

The response of GDP growth to shocks to the interest rate is negative but weak and non persistent. Finally, the inflation rate has a positive response to shocks to the interest rate. This result is known in the literature as the "price puzzle" (Fig. 7). The conventional interpretation for this result is that shocks to the interest rate mainly reflect policy actions in response to inflationary pressures and that it is reasonable to find an immediate positive response of inflation to those pressures, which had been even higher in the absence of a policy action. This intuition seems not plausible for an inflationary regime like that of Argentina by the end of 1970s and the 1980s. In this context, one can expect that shocks to the nominal interest rate mainly reflect inflation expectations, thus leading to decreasing real money holdings and fueling the inflationary process as we were able to also capture through money velocity analysis in Section 4.2 This dynamics is in fact consistent with the observed acceleration of inflation during the 1980s which in turn ended in a hyperinflation.

Our presumption about the role played by inflation expectations driving movements on nominal interest rates cannot be completely corroborated, since it is quite difficult to identify the inflation expectations component of the interest rate, which seems to play a key role over this period. We made however, the exercise of estimating a VAR model excluding the nominal interest rate in order to check which of the variables seems to capture its impact on the rest of the variables in the system. Interesting results come from this exercise: (i) the response of money growth to inflation becomes significant and (ii) GDP negatively responds to shocks to the inflation rate. Thus when we exclude the interest rate the variable capturing the role of inflation expectations is inflation itself, which was at that time very persistent, what fits with the notion of inflation expectations being highly 'backward looking'.[20]

[20] The result of this exercise are available upon request.

Variance decompositions are shown in Table 3 from which it can be observed that movements on the nominal interest rate are mainly explained by its own variability. At the same time shocks to the nominal interest rate contribute to explain a high proportion of the variability of the rest of the variables in the system. In particular 50% of the variability of money growth is explained by shocks to the interest rate, while at the same time it explains 35% of the variability of the nominal exchange rate. Inflation dynamics is mostly endogenously driven, with interest rates and money growth shocks explaining approximately 80% of its variability. This result is in line with the prediction of money demand governed by the inflation expectation component of interest rates under a high inflation regime.

Summing up, during the period of high inflation, money growth and inflation appear to be mainly driven by inflation expectations implied in the nominal interest rate. Shocks to the interest rate have a significantly positive effect on money growth and inflation and a negative effect on GDP growth.

(ii) *Short-run dynamics under low inflation* (1993–2006)

Results of estimating a VAR model for the low inflation period are summarized in Fig. 8 and Table 4 that show impulse-response functions and variance decomposition respectively. The model includes

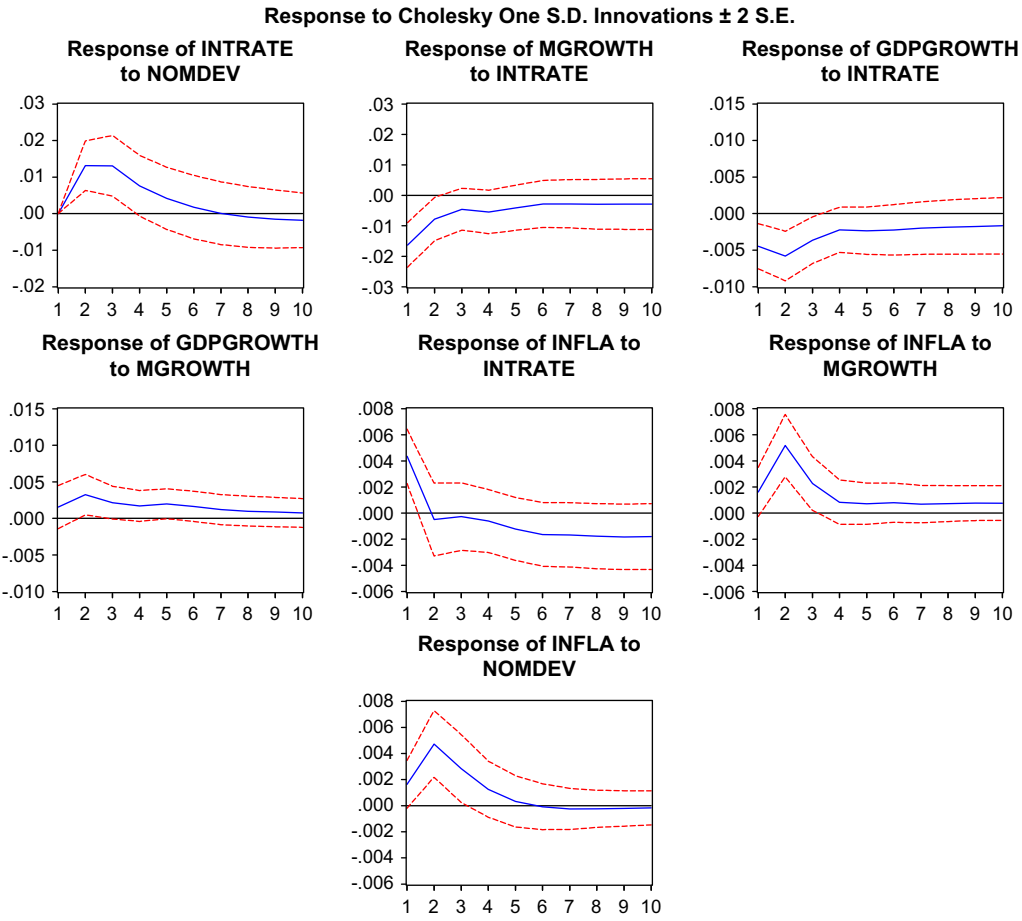

Fig. 8. VAR model 1993Q1–2006Q4 impulse-response functions.

Table 4
VAR model 1993Q1–2006Q4 variance decomposition.

Quarter	INTRATE	MGROWTH	NOMDEV	GDPGROWTH	INFLA
Responses to nominal interest rate shocks (INTRATE shocks)					
1	100	32.23	2.09	15.10	19.84
2	71.41	31.99	3.81	24.11	11.25
3	59.99	28.36	4.42	26.23	9.72
4	59.69	27.31	4.82	26.59	9.51
5	60.18	26.89	5.28	26.90	9.85
6	59.93	26.51	5.62	27.20	10.70
7	59.35	26.25	5.95	27.42	11.50
8	58.91	26.14	6.31	27.61	12.34
9	58.58	26.10	6.66	27.79	13.19
10	58.34	26.12	6.96	27.96	13.94
Cholesky ordering: INTRATE MGROWTH NOMDEV GDPGROWTH INFLA					
Variance decomposition of INFLA					
1	19.84	3.85	2.09	0.12	74.10
2	11.25	19.92	17.45	1.03	50.34
3	9.72	20.37	18.17	1.41	50.33
4	9.51	19.99	17.84	1.51	51.15
5	9.85	19.80	17.24	1.73	51.39
6	10.70	19.86	16.87	1.75	50.82
7	11.50	19.87	16.68	1.80	50.15
8	12.34	19.89	16.47	2.00	49.30
9	13.19	19.93	16.25	2.30	48.34
10	13.94	19.97	16.02	2.62	47.44
Cholesky ordering: INTRATE MGROWTH NOMDEV GDPGROWTH INFLA					

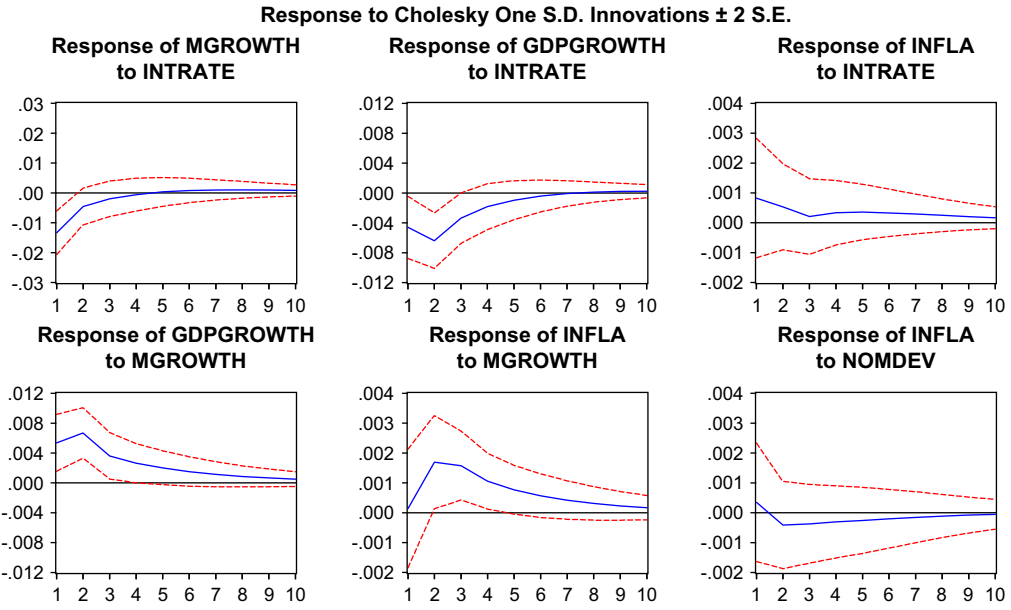

Fig. 9. VAR model 1993Q1–2001Q4 impulse-response functions.

a dummy variable controlling for the effects of the sharp depreciation of the peso during the first quarter of 2002.

Results are more in line with the empirical evidence for low inflation economies. Shocks to interest rates have a predictable negative effect on money growth and GDP growth. Inflation responds positively to both money growth and nominal depreciation shocks (see Fig. 8).

Variance decompositions show that the dynamics of the inflation becomes more exogenously driven. Finally, a high proportion of the variability of GDP growth is explained endogenously, mainly by impulses to the nominal interest rate and to money growth.

Although from previous analysis we do not identify a regime change after the abandoning of convertibility, the low inflation period (1993–2006) includes two different monetary schemes: a hard peg between 1991 and 2001 and a managed float between 2002 and 2006. Thus, we found interesting to study the convertibility period separately.

Fig. 9 shows some of the impulse-response functions for the convertibility period, under which the nominal exchange rate to the dollar remained fixed to provide a nominal anchor to the economy. As for the complete low inflation period, we find that shocks to interest rates have a negative impact on money growth, while shocks to money growth have a positive effect on inflation and GDP growth.

Nevertheless, some interesting differences appear: The response of inflation to shocks to money growth is weaker, consistently with the passive role of monetary policy under the hard peg. From variance decomposition analysis it can be seen that the dynamics of inflation is almost exogenous, with 70% of its movements due to its own shocks (see Table 5).

To sum up, under high inflation money growth, inflation, and nominal depreciation respond positively to increases in nominal interest rates which mainly reflect higher inflation expectations. On the contrary, under low inflation, results are more in line with the stylized facts for industrial countries. Higher interest rates have a negative effect on money growth, nominal depreciation and GDP growth. The abandonment of convertibility did not imply a significant change in the relationship between money and prices, although we find a more important role of money growth in explaining inflation

Table 5
VAR model 1993Q1–2001Q4 variance decomposition.

Quarter	INTRATE	MGROWTH	NOMDEV	GDPGROWTH	INFLA
Responses to nominal interest rate shocks (INTRATE shocks)					
1	100.00	33.06	1.62	12.69	2.14
2	94.13	29.28	0.99	24.93	2.47
3	92.02	26.99	1.58	26.85	2.42
4	90.73	25.67	2.64	27.00	2.61
5	89.77	24.95	3.63	26.83	2.87
6	89.10	24.60	4.44	26.62	3.09
7	88.66	24.45	5.05	26.48	3.26
8	88.38	24.41	5.48	26.39	3.39
9	88.21	24.41	5.76	26.35	3.48
10	88.11	24.43	5.94	26.33	3.54
Cholesky ordering: INTRATE MGROWTH NOMDEV GDPGROWTH INFLA					
Variance Decomposition of INFLA					
1	2.14	0.00	0.52	0.36	96.98
2	2.47	6.77	0.80	4.43	85.53
3	2.42	11.29	1.09	4.52	80.68
4	2.61	12.86	1.31	4.52	78.70
5	2.87	13.59	1.47	4.52	77.55
6	3.09	13.95	1.58	4.52	76.86
7	3.26	14.13	1.65	4.51	76.45
8	3.39	14.21	1.69	4.51	76.21
9	3.48	14.25	1.71	4.50	76.06
10	3.54	14.27	1.72	4.50	75.98
Cholesky ordering: INTRATE MGROWTH NOMDEV GDPGROWTH INFLA					

behavior after the adoption of the managed floating in 2002. Money growth is relevant to explain inflation dynamics in the short-run under both, high and low inflation.

5. Conclusions

Adopting a time-series approach we focus on the Argentine economy to study the regime dependence of the money growth–inflation relationship. Argentina provides an excellent opportunity to study this dependence since it went through dramatic regime changes: very high inflation in the 1970s and 1980s, hyperinflation in 1989 and 1990 and low inflation since then on.

From the long-run perspective, inflation is positively related to money growth and proportionality seems to hold for the whole sample. However, when we split the sample according to regime changes, proportionality continues to hold for the high inflation period, but the relationship is much less than proportional for the low inflation period. Consistently with this result, cointegration analysis indicates the presence of a changing common trend between money and the price level along the whole sample: Under high inflation proportionality cannot be rejected, but under low inflation the long-run relationship between these two variables is much less than proportional.

Money velocity correlates positively with money growth for the high inflation regime, consistently with the theoretical prediction of a low real money demand in this environment. Under low inflation, our results are consistent with the cross-country evidence of a negative correlation between money growth and velocity for low inflation countries.

When we focus on the transmission of nominal shocks to inflation in the short-run, considering an extended set of information, we are able to identify very different dynamics of money growth and inflation depending on regime. During the high inflation period, nominal interest rates are largely determined by inflation expectations. Positive shocks to the interest rates have a positive effect on inflation, suggesting that interest rates are in this context highly governed by inflation expectations. Previous bivariate analysis was not able to capture this relevant feature of the money growth–inflation relationship under high inflation.

For the low inflation period short-run dynamics changes significantly. Results are more in line with the stylized facts in the literature. Shocks to the interest rates have a strong negative effect on money growth and GDP growth. In addition, the inflation rate responds positively to impulses on money growth. Contrary to what might be expected, the abandonment of convertibility did not imply a significant change in the money–price relationship, although we find a more active role of money growth in explaining inflation dynamics. Our results also give evidence that money continues to play a role in explaining inflation in Argentina even under low inflation. They also suggest that the approach of disregarding money in macro modeling for policy purpose, could be missing some relevant information to assess the future trend of inflation.

Acknowledgements

The opinions we express here are ours and do not represent the views of the BCRA. We want to thank Tamara Burdisso for having collaborated in evaluating the time-series properties of the variables used in this paper and to Federico Traverso who collaborated constructing a time series of Nominal GDP. We also thank Pedro Elosegui, George McCandless and Diego Bastourre for their useful comments and those received at the XLI Annual Meeting of the *AAEP* in November 2006 and XI Meeting of Research Network of Central Banks of the Americas. We are also indebted to Hernán Lacunza, Fernando Navajas, Daniel Heymann and Ernesto Gaba for their thoughtful reading of previous versions of this paper. Finally, we greatly thank enriching comments by Jerry Dwyer, Paula Tkac and other participants at the Conference on "Money and Monetary Policy" held at the Fordham University, New York in October, 2008.

Appendix 1. Some empirical regularities in money growth (μ) and inflation (π).

	1977:1–2006:12		1977:1–1988:12		1989:1–1991:3		1993:1–2001:12		2002:01–2006:12		1993:01–2006:12	
	μ	π	μ	π	μ	π	μ	π	μ	π	μ	π
Mean (%)	0.0635	0.0614	0.0921	0.0968	23.3102	25.9425	0.0036	0.0009	0.0275	0.0108	0.0120	0.0044
Std. Deviation	0.110	0.107	0.095	0.056	0.201	0.266	0.050	0.004	0.070	0.015	0.058	0.011
Monthly change correlation (5% significance)	0.791 Yes		0.577 Yes		0.751 Yes		0.207 Yes		0.195 Yes		0.287 Yes	
Annual change correlation (5% significance)	0.974 Yes		0.893 Yes		0.980 Yes		0.790 Yes		0.787 Yes		0.838 Yes	
Granger causality from μ to π (lags)	Simultaneous (2, 6, 12)		Inverse (2, 6, 12)		No		Yes (2, 12)		Yes (2, 6)		Yes (2, 6)	

Appendix 2. Unit-root tests.

	Lm1_sa (with mean and 3 lags)			Lipc (with mean and 3 lags)			Critical value at 10%
	Statistic	Date	Conclusion	Statistic	Date	Conclusion	
Ho: unit-root							
Dickey–Fuller A.	−1.45		Not rejected	−1.54		Not rejected	−2.58
Phillips–Perron	−1.17		Not rejected	−1.39		Not rejected	−2.58
Recursive							
Min ADF	−3.17	2005.II	Not rejected	−7.37	2005.II	Rejected	−4.00
Max ADF	1.76	1989.III	Not rejected	−1.23	1989.III	Not rejected	−1.73
Rolling							
Min ADF	−17.56	1996.IV	Rejected	−40.83	1997.II	Rejected	−4.71
Max ADF	1.25	1989.III	Not rejected	3.93	2002.II	Not rejected	−1.31
Ho: no changes in mean							
Sequential mean shift							
Max F	112.67	1991.II	Rejected	99.10	1990.IV	Rejected	16.20
DF F max	4.93	1991.II	Not rejected	5.22	1990.IV	Not rejected	−4.52
Min DF	−1.94	1996.IV	Not rejected	−1.36	1996.I	Not rejected	−4.54
Ho: no changes in trend							
Sequential trend shift							
Max F	72.18	1990.II	Rejected	59.29	1990.III	Rejected	13.64
DF F max	−4.42	1990.II	Rejected	−4.60	1990.III	Rejected	−4.19
Min DF	−4.78	1991.III	Rejected	−4.70	1991.I	Rejected	−4.20

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