Monetary Policy in Latin America in the 1990s

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For decades until the early 1990s, Latin America was the region of the world with the highest average level of inflation. High inflation was the cumulative result of a long history of activist economic policies based on a disregard for macroeconomic stability. These policies culminated in large government deficits that ended up being monetized by the central bank, or in balance of payments crises that resulted in sharp adjustments in exchange rates. The period was one of fiscal dominance, in the sense that monetary policy was primarily dictated by fiscal considerations. Then, in a substantial departure from previous policies, the quest for greater stability that had begun in the industrial countries in the early 1980s reached Latin America by the end of that decade. As a result, in the 1990s country after country put in place mechanisms aimed at reducing inflation toward single-digit annual levels.

The results have been dramatic. In the 1980s four Latin American countries experienced average rates of inflation over 200 percent per year, and the average for the region had reached 145 percent. But by the end of the 1990s the average inflation rate for the region was below 10 percent. Among the larger countries, only two, Mexico and Venezuela, had inflation rates above 15 percent per year. And of these two, Mexico is well on the way toward achieving single-digit annual inflation.

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Many factors lay behind the decision to make a frontal attack on inflation. First, the poor inflation record of the 1980s entailed high political and economic costs. Second, an overwhelming amount of analytical and empirical evidence had shown that trying to achieve a permanent reduction of unemployment through loose monetary policy results, eventually, in an acceleration of inflation with little permanent effect on the unemployment rate.[1] That is, the short-term Phillips curve trade-off between inflation and unemployment, so popular in the 1960s and early 1970s, tends to vanish in the long run. Third, there was an increasing awareness that, with forward-looking expectations and credible policies, the cost of reducing inflation is much lower than previously thought (Sargent, 1982). Fourth, the consensus became widespread among economists that sensible macroeconomic policy contributes to sustainable growth, although it does not ensure it. As a corollary, there is today widespread agreement that the best contribution that monetary policy can make to long-term growth is to make inflation low and predictable.[2] Fifth, it became increasingly clear that inflation gives rise to a form of regressive taxation and results in nonnegligible welfare effects. These mainly affect the poorest groups in the population, who are less able to deal with inflation and tend to hold an unusually high ratio of non-interest-earning monetary assets to income (Bulir and Gulde, 1995). Sixth, it was realized that the costs of inflation are highly nonlinear with respect to the level of inflation, making the reduction of high inflation a worthwhile undertaking (Bruno, 1991). Finally, a seventh factor was the emergence of a large group of well-trained Latin American economists and their success in reaching high-level positions in the governments of their countries.

Once the decision to reduce inflation to single-digit annual levels has been made, the issue is how to go about getting the job done. This question of anti-inflation strategy is directly related to the question of the most appropriate monetary policy regime or framework. Here there are three options to be considered: an exchange rate anchor, a money anchor, and an inflation target anchor. Section 1 of this paper studies the elements to be considered in the choice of

1. For recent discussions of these developments, see Goodhart (1994) and Fischer (1995, 1996).

2. Some of the same factors have also been behind policy changes in developed countries geared to achieving price stability. See Fischer (1996) and Bernanke and others (1999).

a monetary framework. Once a framework has been chosen, it has to be decided how to conduct monetary policy within the chosen framework. This is the subject of section 2. The section begins by analyzing the institutional underpinnings of monetary policy in five countries: Chile, Colombia, Costa Rica, El Salvador, and Peru, and then turns to the practice of monetary policy in a wider group of nine countries: the five just named plus Argentina, Bolivia, Brazil, and Mexico. Section 3 then investigates empirically how the central banks of Chile, Colombia, Costa Rica, El Salvador, and Peru have conducted monetary policy in recent years, and in particular whether the central bank's behavior changed after it became independent. For this purpose monetary policy reaction functions are estimated for the five countries. Finally, section 4 presents the main conclusions.

1. The Choice of a Monetary Policy Regime

Three basic strategies can be envisaged for the choice of a monetary policy regime to anchor inflation.[3] The first is fully orthodox: monetary targeting relies on a precommitted path for the money supply to anchor inflation. The second, exchange rate targeting, uses the exchange rate as the nominal anchor. The third, increasingly popular strategy is inflation targeting, where the anchor for inflation is the publicly announced inflation target and the commitment of the central bank to gear monetary policy toward achieving this target.

In all three cases, but especially the first and the third, the attempt at stabilization probably induces slower economic growth at first. The exchange rate anchor, in contrast, is usually first accompanied by an expansion, followed by a recession (Calvo and Végh, 1999). In choosing among these three approaches, it is important to take into account the degree of openness of the economy and the stability of the relationship between monetary aggregates and inflation.

1.1 The Exchange Rate Anchor

Setting a value for the exchange rate in a small, open economy provides an anchor for the price level by exerting a direct effect, through

3. On monetary anchors see Calvo and Végh (1999), Bernanke and Mishkin (1997), and Bernanke and others (1999).

arbitrage forces, on the prices of tradable goods.[4] That is, tradable goods prices become the nominal anchor for the whole economy.[5] If the exchange rate is fixed with respect to the currency of a low-inflation country, and the peg is credible, it also serves to reduce inflation expectations toward the level of inflation in the low-inflation country. Another advantage of using an exchange rate anchor is that it is directly observable, and therefore the public at large can understand it much more easily than a monetary rule.

However, an exchange rate anchor also has some disadvantages. The first is that, if it has an open capital account, the pegging country cannot run an independent monetary policy. It loses the ability to use monetary policy to respond to domestic and external shocks, especially those that affect aggregate demand. This is not an insignificant cost for large and medium-size countries that are exposed to frequent aggregate demand shocks (mostly to the terms of trade) and that have the technical and institutional capacity to carry out an independent monetary policy. But the cost may be less important for countries that cannot practically carry out an independent monetary policy in any case. This would include countries with extensive currency substitution, and countries where a large proportion of the liabilities of the financial system is denominated in foreign currency.[6] Second, domestic interest rates (adjusted for country risk) become determined by the interest rate of the anchor country, and therefore interest rate shocks in the anchor country are transmitted directly to the pegging country. In cases where the economic cycles in the two countries are far out of phase, such a monetary shock would have real costs in the pegging country. Third, with perfect capital mobility the use of an exchange rate anchor exposes the country to speculative attacks. This has become increasingly clear in the recent crises in emerging markets. The defense against these attacks involves the

4. Following the Mexican crisis of 1994-95 and the Asian crises of 1997-98, the debate on the most appropriate exchange rate system has taken a new twist, with the discussion today framed more in terms of feasibility than of optimality (see, in particular, Obstfeld and Rogoff, 1995, and Eichengreen, 1999).

5. In this system, given a trajectory for the price of tradable goods (and assuming that they obey the law of one price), the trajectory of domestic inflation is obtained by dividing the nominal price of tradable goods (expressed in local currency) by the real exchange rate (a real variable).

6. In some countries the central bank may lack the technical capacity to carry out an independent monetary policy *other* than one based on an exchange rate anchor. This could be the result of a deliberate decision based on the advantages expected from operating within an optimal currency area as described by Mundell (1961).

use of high interest rates for a protracted period, and this is costly in terms of the resulting high unemployment and the deterioration of bank portfolios. High interest rates also set the stage for the abandonment of the peg, as economic agents come to believe that the high cost of defending the peg will eventually lead the pegging country to abandon it. There are also, in most cases, high and highly nonlinear costs when a peg is abandoned in favor of a large devaluation (Obstfeld and Rogoff, 1995; Eichengreen, 1999).

But this is not all. The fixing of the exchange rate also requires that other indexation mechanisms in the economy be discarded and that an appropriate institutional structure be developed to prevent the financial system from becoming too vulnerable to an eventual exchange rate correction. Such a structure can be developed through appropriate financial sector regulation. Potential problems along these lines are best illustrated by the experience of Chile in the late 1970s (Corbo and Fischer, 1994), Mexico in 1994-95 (Dornbusch and Werner, 1994), the Asian countries in 1997-98 (International Monetary Fund, 1997), and Russia in 1998. Brazil in 1999 is the exception that confirms the rule. In Brazil, the early-1999 devaluation corrected an accumulated real appreciation that had built up while the exchange rate was being used as an anchor to reduce high inflation. Rather than triggering a severe crisis, it set the stage for a recovery.

Another potential side effect of fixing the exchange rate in the presence of an open capital account is undue risk taking and, as a consequence, an unsustainable expansion of credit. This can result in a financial bubble, increasing financial fragility in the process (Corbo and Fischer, 1995; Edwards and Végh, 1997; Mishkin, 1997). This problem is illustrated by the experience of Chile in the early 1980s and of Mexico in the first half of the 1990s, and by the recent experience of Asia (especially Indonesia, Korea, Malaysia, and Thailand). In all these cases, following the fixing of the exchange rate, the initial spread between the domestic and the foreign interest rate—adjusted for the expected rate of devaluation—rose sharply, providing substantial encouragement for capital inflows and credit expansion. This increase in the spread could also have been due to an inconsistent fiscal policy. But in all these countries the final result was a combination of large capital inflows, an expenditure boom, and a sharp real appreciation. A sudden reversal of capital flows was then all it took to precipitate a major crisis. Also, fixing the exchange rate in the presence of nominal rigidities can distort resource allocation if the real exchange rate then departs from its equilibrium level.

In practice, an exchange rate anchor usually takes the form of a predetermined nominal path for the rate of currency devaluation (that is, a crawl), but it could also be a fixed rate against the currency of another country.[7] Fixed rates come in three varieties: simply fixed, without any supporting institutional changes; fixed within a stronger institutional framework; and the abandonment of the local currency in favor of a common currency or the currency of another country. Examples of the second type are the currency boards adopted in Argentina and Hong Kong. Examples of the third type are the European countries that have decided to participate in monetary union, and Panama's abandonment of its local currency in favor of the U.S. dollar. In the latter case, the probability of an adjustment in the "peg" is negligible. Preconditions for successful implementation of the last two types are order in the fiscal accounts, a robust financial system, and sufficient foreign reserves to back the monetary and financial (local currency denominated) liabilities of the central bank (International Monetary Fund, 1999). It could be argued, however, that if all these conditions are fulfilled, there is little to be gained from a currency board or full dollarization.

For medium-size and large economies that have rigid labor and commodity markets, fixed rates may make the adjustment to a demand shock unduly costly. In particular, for this type of country a real depreciation, when required by a change in the fundamentals, could become too costly, given that it depends on the downward flexibility of nontradable goods prices. In this case a more flexible exchange rate regime would be preferable. Indeed, as the adjustment to the external shocks of 1999 has illustrated, the combination of prudent monetary policy and exchange rate flexibility has facilitated adjustment in most countries in the Latin American region. But a properly functioning flexible exchange rate system also requires a well-capitalized, well-regulated, and well-supervised financial system. Otherwise, changes in the market value of the exchange rate could result in serious difficulties due to a mismatch in the currency denomination of assets and liabilities, with severe macroeconomic consequences. But this is not all. It is also necessary to have in place the institutions and procedures for the development of a market for hedging exchange rate risks.

7. Predetermined rates of devaluation were used in the 1970s in the ill-fated "tablita" experiments of the Southern Cone countries (Corbo and de Melo, 1987).

Even assuming all these actions are taken, many questions remain open with regard to the most appropriate monetary arrangement for a particular country. Following the early success of Argentina's currency board system, some countries in the region have given serious consideration to doing likewise. But before jumping into such a rigid system, it is important to understand that Argentina, a country with a long history of abusing its monetary and exchange rate policies, essentially had no alternative. Countries thinking of following Argentina's path should also remember that a currency board is not a panacea. To start with, a country has to have sufficient foreign reserves to finance the short-term monetary liabilities of the monetary system; otherwise the system will not be credible. Furthermore, the financial system must be strong enough to survive without a lender of last resort. If this is not possible, arrangements must be made for access to emergency lending from foreign commercial banks, as Argentina has done, or from an external official institution, most likely the U.S. Federal Reserve or the European Central Bank. Moreover, wage flexibility and labor mobility must be high enough to facilitate changes in relative prices between tradable and nontradable goods when called for by a change in the macroeconomic fundamentals. Otherwise price rigidities will give rise to substantial welfare losses. Ultimately, the discipline of a currency board requires that the government be ready and have the political support to live with the high interest and unemployment rates that are an integral part of adjustment when the country faces a shock that requires a real depreciation.

Countries that are not ready or willing to go the route of currency boards or full dollarization, and decide instead to use a flexible exchange rate system, need to choose an appropriate monetary framework capable of generating low and predictable inflation. Such a framework requires giving sufficient independence to the central bank to allow it to focus its monetary policy on the ultimate objective of low inflation without resorting to the exchange rate peg as an anchor. Here the options are the use of a money anchor or some other explicit nominal anchor as an inflation target.

1.2 A Money Anchor

Effective use of a monetary aggregate as a nominal anchor for inflation depends, first of all, on the authority and capacity of the central bank to carry out an independent monetary policy aimed at

achieving and maintaining low inflation. But this is not all. At a more technical level, the effectiveness of a monetary anchor depends on the stability of demand for the monetary aggregate to be used as the anchor. It is this stability that provides the link between the monetary aggregate and the rate of inflation. Instability of the demand for money presents a problem in cases where there is considerable financial innovation or a sudden change in the rate of inflation.

In particular, in an economy that has experienced a period of high and variable inflation, the demand for money becomes very unstable as economic agents develop ways to economize on the use of money balances. When inflation is finally reduced, hysteresis effects emerge, generating a breakdown in the old demand-for-money relationship. In cases like these, predicting the quantity of money demanded becomes very difficult, and the use of a monetary target may be a very ineffective way to achieve a given inflation objective. It may be more appropriate to use an exchange rate anchor in the initial stages of the stabilization program, to be followed later by a more flexible exchange rate system accompanied by a monetary or inflation target.

1.3 Inflation Targeting

Given the problems with the use of an exchange rate or a monetary anchor, in recent years some countries have moved to a third type of anchor: inflation targeting. This type of monetary framework was initially introduced in certain industrial countries with the objective of keeping inflation close to a desired low long-run level. New Zealand introduced an inflation targeting system for this purpose in March 1990. Similar systems have since been introduced in Canada (February 1991), the United Kingdom (October 1992), Sweden (January 1993), and Australia (September 1994). The European Central Bank adopted the approach in October 1998. Variants on this system, aimed at adjusting inflation first toward single-digit annual levels and eventually toward a steady-state low level, have been introduced in a series of nonindustrial economies, starting with Chile in September 1990 and Israel in March 1991.[8]

In inflation targeting, the target rate of inflation is the monetary anchor, and both monetary and fiscal policies are geared toward achieving the target. The attractiveness of this system is that

8. See Fry and others (1999).

its effectiveness does not depend on a stable relationship between a monetary aggregate and inflation, and at the same time it avoids the problems associated with the fixing of the exchange rate reviewed above. An additional advantage for emerging market countries is that the trajectory of the market exchange rate provides important information on the market evaluation of present and future monetary policy; the exchange rate thus plays the same role that nominal yields on long-term government paper play in industrial countries (Bernanke and others, 1999).

A well-defined inflation targeting framework goes well beyond just setting a target for the inflation rate; rather, it requires a series of actions (Svensson, 1999a; King, 2000). First, there should be a public announcement of a strategy of medium-term price stability and of an intermediate target for inflation for a time period over which monetary policy can realistically claim to affect the level of inflation. Second, there should be an institutional commitment to price stability in the form of rules of operation for the monetary authority. Third, a clear strategy is needed, delineating how monetary policy, through the adjustment of interest rates, is going to operate to bring inflation close to the announced target. A full inflation targeting strategy usually starts from a conditional interval forecast of inflation for the period utilized for setting the target. It also has to specify an operational procedure for the central bank to follow when the inflation forecast is above or below the target. These procedures should be transparent, and the monetary authorities should be made accountable for reaching the objective that has been set.

Given the normal lags in the operation of monetary policy, the inflation target has to be set for a period far enough into the future that monetary policy can actually have an effect. In practice, central banks in industrial countries announce a target for the next twelve or twenty-four months. They then develop a conditional forecast of inflation, based on existing monetary policy and a forecast of the relevant exogenous variables, and set a strategy and communicate to the public what they will do if the range forecast for inflation does not include the targeted value. In emerging market economies, however, where financial markets are not as well developed and liquidity constraints are widespread, there is some evidence that the lags of monetary policy are shorter (Fry and others, 1999).

In this framework, the established inflation target is the ultimate objective of policy, and an inflation forecast, sometimes not made public, is the intermediate objective. Monetary policy, with

appropriate fiscal underpinnings, is the main instrument used to pursue the target. In particular, when the conditional inflation forecast is above the inflation target, the level of the intervention interest rate is raised so as to achieve an increase in the real interest rate that will bring inflation closer to the target. One advantage of inflation targeting is that inflation itself is made the target, committing monetary policy to achieve the set target and thus helping to shape inflation expectations. Here, too, however, resides the main disadvantage of inflation targeting. Because inflation is an endogenous variable that depends also on factors that go beyond the stance of monetary policy (for example, on shocks to the terms of trade and to aggregate supply and demand), the authorities cannot control inflation directly. As a result, it becomes difficult to evaluate the stance of monetary policy on the basis of just the observed path of inflation. Furthermore, because monetary policy works with a substantial lag, if the authorities precommit to an unconditional inflation target independently of changes in external factors that also affect the inflation rate, it can be costly to change monetary policy to bring inflation back to the set target. In particular, to persist in aiming for the inflation target when a shock has resulted in a (temporary) rise in the inflation rate can produce a severe slowdown or increased output volatility (Cecchetti, 1998). On the other hand, accommodating the external shock could result in a loss of credibility for the inflation targeting regime.

To address some of these problems, several options have been proposed. The first is to set the inflation target in terms of a range rather than a point estimate. A second is to set a target for core inflation rather than for some broader measure of inflation. A third is to exclude from the price index the effects of changes in indirect taxes and in the terms of trade. A fourth is to set the target for a horizon long enough that short-term shocks to the inflation rate do not require a monetary response (on these point see, in particular, the discussion in Bernanke and others, 1999).

2. The Practice of Monetary Policy in Latin America

As mentioned in the previous section, a successful exchange rate anchor system requires, first of all, a credible peg. In contrast, operating a successful monetary target or inflation targeting strategy requires a central bank with sufficient autonomy to operate monetary

policy as called for by the strategy. Given the crucial role of an independent central bank within a monetary policy framework, this section begins by reviewing the progress made by some Latin American countries in providing greater autonomy to their central banks.

Table 1 presents information obtained from the charters of five Latin American central banks (Chile, Colombia, Costa Rica, El Salvador, Perú). As the table shows, the reforms aimed at enhancing central bank independence in these countries were mostly implemented during the first half of the 1990s. Chile, where a law creating an independent central bank was enacted in October 1989, was the pioneer in introducing this type of reform, both within the region and among emerging market economies worldwide. Elsewhere in Latin America, similar steps were taken later in Colombia (1991), El Salvador (1991), Peru (1993), and Costa Rica (1995). Although in all these countries the reforms had as their common aim to provide a greater degree of central bank independence, they varied considerably in how far they pursued that objective. Following Cukierman (1992), one can identify four broad dimensions of legal central bank autonomy: the clarity of the mandate; the procedures for appointment and dismissal of members of the board of directors; the provisions for resolving conflicts between the executive branch and the central bank and the degree of the latter's influence in formulating monetary policy, exchange rate policy, and the budget; and the existence of legal restrictions on the ability of the public sector to borrow from the central bank.

A review of central bank charters with respect to these four dimensions helps to clarify how far these five Latin American countries have progressed in enhancing central bank autonomy. As table 1 shows, in all five countries price stability is today established by law as one of the key objectives of the central bank. However, in only one country (Peru) is this the central bank's sole legal objective. In the others the central bank also has other objectives, which to varying degrees could conflict with the price stability objective. At one extreme is the objective of promoting the stability of the financial system. This provision, found in the charters of the central banks of Colombia and El Salvador, does not represent an explicit conflict with the price stability objective, if it is interpreted as seeking an appropriate regulatory and supervisory framework. However, there could be a conflict if the provision is interpreted as requiring the central bank to avoid too high a level of the (real) interest rate or to restrict the adjustment of the nominal exchange rate in order to preserve financial system

Table 1. Features of Central Bank Charters in Selected Latin American Countries

	Chile	*Colombia*	*Costa Rica*	*El Salvador*	*Peru*
Year of central bank reform	1989	1991	1995	1991	1993
Legal objectives of the central bank	Price stability Normal functioning of the internal and external payments systems	Price stability Strength of the financial system	Price stability Multiple other objectives, including full employment	Price stability Stability and competitiveness of the financial system	Price stability
Is the finance minister a member of the board?	No	Yes	Yes	No	No
Does the central bank have final authority to formulate monetary policy?	Yes	Yes	Yes	Yes	Yes
Does the central bank have final authority to formulate exchange rate policy?	Yes	In part; the exchange rate regime is defined by the legislature	Yes	Yes	Yes
Is the central bank authorized to finance the government?	No	No	No	No	No

Source: Corbo et al., 1999

stability. At the other extreme, the objective of full employment, which appears only in the charter of the Costa Rican central bank, could conflict with the price stability objective if full employment is defined as a short-term objective.

The five countries also vary significantly in terms of the second dimension of central bank independence: the appointment and dismissal procedures for the board of directors. In all of the countries except Chile, the president of the board is named directly by the president of the republic for a term of office that coincides with the latter's term of office. Furthermore, in Colombia the president of the central bank board is also the finance minister.[9] Only in Chile and Peru must the president of the board be approved by the legislature; in the other countries the decision is left entirely to the chief executive. How the president of the central bank's board is chosen becomes particularly important when one considers that, in all five countries, the law establishes that in case of conflict within the board, it is the president's vote that resolves the dispute. Thus the president of the board has considerable influence over the monetary policy resolutions made by the board.

All of the five central bank charters provide for the removal of directors. These provisions differ across countries, however, both in terms of the causes that may be invoked for removal and in terms of the institution legally empowered to do so. Of the five countries, only in Costa Rica does the law prohibit removing a director for reasons of policy. In Chile, Colombia, and Peru, although a board member may be removed because of his or her vote on a policy resolution, this can only be done under severely restrictive conditions. For example, in the case of Peru, the legislature may only proceed to dismiss a director when a serious fault has been committed and duly proved, and even then a two-thirds majority is required. El Salvador has probably the least restrictive conditions for removal: the central bank charter establishes that the council of ministers has the authority to dismiss a director who has voted favorably on a resolution that implies a flagrant deviation from the central bank's objectives or from any other responsibility that the law imposes.

Another important dimension of autonomy has to do with the authority given to the central bank to formulate monetary and exchange rate policy. All of the five countries have final authority to

9. In Costa Rica the finance minister is a member of the board but not the president.

decide the course of monetary policy, and only in Colombia are monetary policymakers constrained by the legislature in the choice of exchange rate regime. In all the other countries the decision about the exchange rate system is left entirely to the central bank.

Finally, none of the five countries allows its central bank to finance the government's budget. This represents an important step toward establishing the central bank's independence from fiscal authority.

This examination of the central bank charters of these five Latin American central banks shows that they have gained increasing independence in running monetary policy. The next step is to examine how they have carried out that policy in practice. As discussed in the previous section, three choices of anchor for a monetary policy regime can be distinguished: an exchange rate anchor, a money anchor, or an inflation target. Table 2 provides a broad overview of the monetary policy regimes used by nine Latin American countries. As can be seen, the monetary mechanisms utilized vary a great deal from country to country, but inflation targeting is the predominant framework used in these countries today. Four of the nine countries (Brazil, Chile, Colombia and Mexico) adopted this framework during the 1990s. All four countries went through a transition period, during which credibility was built and inflation was gradually reduced. During this period the inflation target was not explicit, but rather was usually stated in terms of achieving a gradual reduction of inflation toward levels in industrial countries. Neither any interim target nor the duration of the transition was spelled out. Once they had made sufficient progress in reducing inflation, most countries then started to use explicit targets, in the form of annual targets (a point or a range) publicly announced at the end of the previous year.

However, only Brazil and Chile have revealed a well-articulated inflation targeting procedure. That is, they publish information on their conditional inflation forecasts and on the procedures to be followed when the inflation forecast lies outside the announced target range. These are similar to the inflation reports published by industrial countries' central banks (and now by Israel's central bank as well).

Three countries (Bolivia, Costa Rica, and Peru) use some sort of monetary target to conduct monetary policy. What is somewhat striking is the fact that two of these countries (Bolivia and Peru) have experienced hyperinflationary episodes in the past, which might have introduced considerable instability in the demand for money through hysteresis and currency substitution effects. Also, in all three cases the development of financial markets—with the associated innovations

Table 2. Features of Monetary Policy Targeting in Selected Latin American Countries

Country	*Type of target*	*Is the target implicit or explicit?*	*Who sets the target?*	*Is the target single or multiple?*
Argentina	Exchange rate	Explicit	Congress	Single
Bolivia	Monetary	Implicit	Central bank alone	Single
Brazil	Inflation	Explicit	Central bank and finance ministry	Single
Chile	Inflation	Explicit	Central bank and finance ministry	Single
Colombia	Inflation	Explicit	Central bank alone	Single
Costa Rica	Monetary	Implicit	Central bank alone	Single
El Salvador	Exchange rate	Implicit	Central bank alone	Single
Mexico	Inflation	In transition from implicit to explicit	Central bank alone	Single
Peru	Monetary	Implicit	Central bank alone	Single

Source: Author's elaboration in base of information provided by central banks.

in financial instruments and intermediaries— followed the introduction of broadly based reforms, and this might have contributed to weakening the link between monetary aggregates and inflation. Another interesting point is that all of the countries that rely on a monetary target do not announce publicly what that target will be for the next period. As Mishkin (1999) has pointed out, this lack of transparency leads to "confusion in the market place, a lack of accountability of the central bank, and a missed opportunity to focus the public and politicians on the need for a long-run orientation of monetary policy." Several authors have emphasized the importance of transparency of the monetary framework as a way to control discretionary behavior by authorities that could lead to poor long-run outcomes. As King (2000) recently put it, "The communication of policy makers' intentions with a view to enhancing their credibility has come to play a central role in monetary policy."

Two countries (Argentina and El Salvador) have adopted an exchange rate target, although under radically different institutional frameworks. The Argentinean authorities are committed by law to maintain one-to-one parity between the peso and the U.S. dollar and have established a currency board to comply with that legal mandate. In contrast, policymakers in El Salvador have adopted a de facto fixed exchange rate with no clear commitment to maintain the parity.[10] The circumstances that led these two countries to adopt their monetary policy regimes also differ. In Argentina the currency board system was adopted in 1991 as a way to deal with the monetary authority's lack of credibility in the context of a long history of high and variable inflation. In contrast, El Salvador adopted its fixed exchange rate system in 1993, when inflation was moderate (the annual inflation rate was near 20 percent).

3. Monetary Policy Rules: The Cases of Chile, Colombia, Costa Rica, El Salvador, and Peru

This section investigates empirically how monetary policy has been conducted in these five countries in recent years. For this purpose we follow closely the reaction function methodology developed by Taylor (1993) and extended by Clarida, Galí, and Gertler (1998a).

10. However, recently (early 2001) El Salvador has been making preparations towards the introduction of a currency board.

In general, the monetary authority's reaction function results from an optimization problem, where it is assumed that the authority minimizes a loss function on the squared differences of inflation and its target, and of observed and potential output. The basic specification used here has the central bank adjusting the interest rate (the real rate in Chile, and the nominal rate in the other countries) in response to the gap between expected inflation and its target value. We then add as additional regressors other variables that are spelled out as additional objectives in the central bank's charter (as reviewed in the previous section). Then we investigate empirically whether, in setting monetary policy, the authorities have also considered other variables. Given that the effects of monetary policy appear with a lag, monetary policy responds to lead values of the inflation gap. When choosing additional variables that could have played a role when setting monetary policy, we draw on others' work on the transmission mechanism for an open economy (Ball, 1999 and Svensson, 1999b).

Following Clarida, Galí, and Gertler (1998b), the interest rate is set in accordance with the following reaction function:

$$U_t^* = \bar{U} + \beta\left[\left(\left(\pi_{t+n} \mid \Omega_t\right) - \pi_t^*\right] + \gamma_1\left[\left(\left(y_{t+k} \mid \Omega_t\right) - y_{t+k}^*\right]\right. \\ \left. + \gamma_2\left[\left(\left(z_{t+j} \mid \Omega_t\right) - z_{t+j}^*\right]\right., \tag{1}$$

where the bar over r denotes the long-run equilibrium interest rate, π_{t+n} is the expected rate of inflation between periods t and $t + n$, y_t is (the logarithm of) output, and z_t is a generic variable that we measured in different ways. This variable may be measured as the gap between expenditure and GDP as a share of the latter; as the gap between the rate of growth of expenditure and the rate of growth of GDP; as the current account deficit as a share of nominal GDP; as the foreign interest rate; or as the deviation of the real exchange rate from its trend. The variable r_t^* is the target interest rate set by the central bank, π_t^* is the target rate of inflation (which may be time-variant for a country whose objective is to reduce inflation gradually toward industrial-country levels), and y_t^* is the logarithm of potential output, measured as the trend of GDP.

In this framework the presence of the output gap in the reaction function could arise directly from a concern of the authorities with output volatility, so that monetary policy is adjusted in order to reduce deviations of output from its trend; in this case the output gap is a separate final objective in the policymakers' loss function.

Alternatively, it may arise because the monetary authorities use the information provided by the output gap in their forecast of future inflation; in this case the output gap enters the reaction function as an intermediate objective. To distinguish between these two motives, we used lagged values of the output gap as an instrument for the inflation gap, using the generalized method of moments (GMM) estimation procedure.

When the main objective of monetary policy is to keep inflation close to its target level, the real interest rate should be raised when the inflation gap becomes positive. In a standard transmission mechanism from aggregate demand to price dynamics, it is through an increase in the real interest rate that observed inflation is brought back to its target level when the former exceeds the latter. Thus, in the above model, when monetary policy is carried out using the real interest rate, as in Chile, the value of β should be positive. When monetary policy is carried out using the nominal interest rate, as in the other four countries studied, its value should be also greater than one.[11] Thus the value of β turns out to be a key parameter in assessing the central bank's response.

To complete the model, a partial adjustment equation is added to accommodate the observed propensity of central banks to make smooth and slow, rather than sudden, adjustments of interest rates toward the desired level:

$$r_t = \rho r_t^* + (1-\rho) r_{t-1} + \upsilon_t \,, \tag{2}$$

where it is assumed that υ_t is i.i.d. $(0,\sigma^2)$.
From equations (1) and (2) one obtains the following relation:

$$r_t = \rho \left\{ \begin{array}{l} \bar{r} + \beta\left[\mathrm{E}\left(\pi_{t+n} \mid \Omega_t\right) - \pi^*_{t+n}\right] + \gamma_1\left[\mathrm{E}\left(y_{t+k} \mid \Omega_t\right) - y^*_{t+k}\right] \\ + \gamma_2\left[\mathrm{E}\left(z_{t+j} \mid \Omega_t\right) - z^*_{t+j}\right] \end{array} \right\} \\ + (1-\rho) r_{t-1} + \upsilon_t \,. \tag{3}$$

Finally, assuming that expectations are rational, we replace expected values with realized values, obtaining the following equation:

11. The key assumption here is that the real interest rate is an argument in the real expenditure equation.

$$r_t = \rho\left[\bar{r} + \beta\left(\pi_{t+n} - \pi^*_{t+n}\right) + \gamma_1\left(y_{t+k} - y^*_{t+k}\right) + \gamma_2\left(z_{t+j} - z^*_{t+j}\right)\right] + (1-\rho)r_{t-1} + \varepsilon_t\,, \tag{4}$$

where the error term, ε_t, is a linear combination of the forecast errors of inflation, output, z_{t+j}, and the true disturbance υ_t. Because some of the variables considered in the right-hand side of the equation are also endogenous, the model is estimated using a method—the GMM method—that yields consistent estimates in the presence of simultaneity problems.[12]

3.1 Chile

As we saw in section 1, since the beginning of the 1990s Chile's monetary policy has had as its main objective the gradual achievement of a level of inflation similar to that in the industrial countries. That level has been defined recently as a steady-state annual inflation rate in the range of 2 to 4 percent, starting in 2001. In moving toward this steady-state level, the central bank announces, in September of each year, an annual inflation target for the following year.

To study how much of a trend change in the rate of inflation (which could also affect expectations) has been implied by the set target, we built a multivariate model to forecast inflation. The model is estimated using a rolling regression, and then a forecast is made for the following year. A comparison of the forecast of inflation with the target set by the central bank (figure 1) shows that only in 1993 was the target rate well below the value predicted by the model; however, from 1992 until the end of 1996 it was below the forecasted value. From this we conclude that through most of the 1990s the central bank pursued the objective of a gradual reduction of inflation.

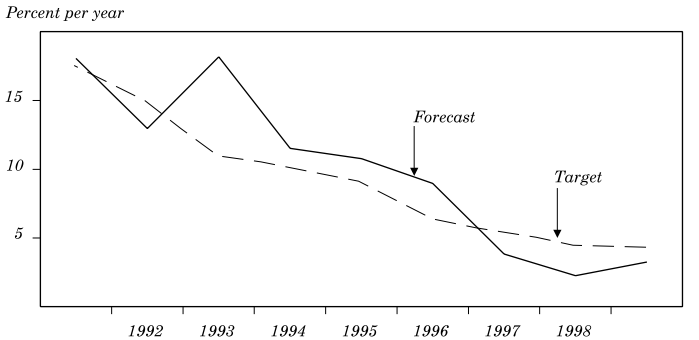
As we saw in table 1, the charter of the Central Bank of Chile assigns it the objective not only of reducing inflation but also of ensuring that the internal and external payments systems function properly. This can be interpreted as saying that, for a given gap between expected inflation and its target, the central bank should also care for other objectives.[13]

12. For descriptions of this method see Hamilton (1994), Enders (1995), Mátyás (1999), and Greene (2000).

13. Corbo (1998) and Rosende (1998) present two different explanations for the mechanism of transmission of monetary policy and for the effective role played by the central bank in the reduction of inflation.

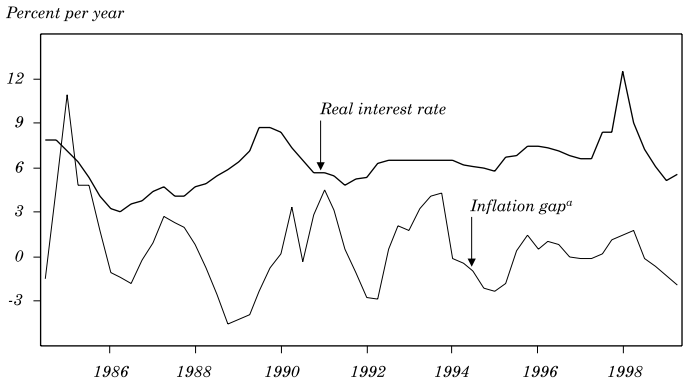
Figure 2 compares the trajectories of the inflation gap and the real interest rate in Chile. It appears that interest rates were raised in advance of increases in the inflation gap. But because monetary policy works with a lag of around three quarters, we also compare the gap between actual inflation and the inflation target with a three-quarter lag in the real rate of interest (figure 3). This figure illustrates quite clearly that monetary policy is adjusted to keep expected inflation close to its target.

Figure 1. Inflation Targets and Inflation Forecasts in Chile



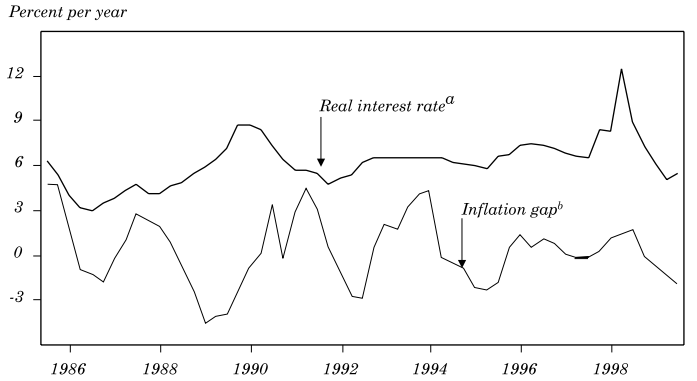
Source: Author's calculations based on Central Bank of Chile data.

Figure 2. Inflation Gap and Real Interest Rate in Chile



Source: Author's calculations based on Central Bank of Chile data.
a. Difference between inflation and its target.

Figure 3. Inflation Gap and Lagged Real Interest Rate in Chile



Source: Author's calculations.
a. The real interest rate is shown with a lag of three quarters.
b. Difference between inflation and its target.

We proceed now to investigate how monetary policy in Chile was carried out in the 1990s and to compare monetary policy during this period with that in the 1985-89 period, immediately before the central bank became independent. In the model that we estimate for Chile, the dependent variable is the real interest rate, because monetary policy is carried out using bonds issued by the central bank that are indexed to the consumer price index (CPI). We used as a baseline an equation in which the only explanatory variable is the expected inflation gap. To accommodate lags in the operation of monetary policy, we explored different leads for the inflation gap and found that monetary policy responds to a three-quarter lead of the expected inflation gap.

The estimations were carried out using quarterly data for the period from 1990Q1 to 1999Q4. A two-period partial adjustment model was used to accommodate the smoothing of interest rates, and a dummy variable was introduced to account for the large increase in the interest rate that took place in the third quarter of 1998, when the exchange rate band came under attack. When this mechanism is used to model the behavior of actual interest rates, the model estimated is a slight departure from the general specification outlined above. The general equation, analogous to equation (4), is given by

$$r_t = (1-\rho_1-\rho_2)\begin{bmatrix}\bar{r}+\beta(\pi_{t+n}-\pi^*_{t+n})+\gamma_1(y_{t+k}-y^*_{t+k})\\ +\gamma_2(z_{t+j}-z^*_{t+j})\end{bmatrix} \qquad (4')$$
$$+\rho_1 r_{t-1}+\rho_2 r_{t-2}+\varepsilon_t\ .$$

The set of instruments used in the GMM estimation includes one-period and two-period lags of the interest rate, the rate of growth of nominal money, the rate of nominal depreciation, the rate of growth of nominal wages, the output gap, and external inflation.

The results of the estimation of the baseline are presented in the bottom panel of table 3. In the baseline model, presented in the first row of this panel, the coefficient on the inflation gap (β) is positive but not statistically significant. This result could be due to a specification error, as the central bank has a separate declared objective to keep the size of the current account deficit, computed at a "normal" level of the terms of trade, below 4 percent of GDP. To incorporate this second objective we extended the basic model by adding as a separate regressor the difference between the fourth-quarter moving average of the current account deficit (as a ratio to GDP) and 0.04. The results are reported in the third row of the bottom panel. The coefficient on the inflation gap is again positive, but now it is statistically different from zero. The coefficient on the current account gap is also positive and statistically significantly different from zero. These findings provide some support to the idea that an equation that includes only the inflation gap is wrongly specified. The estimated coefficient of the inflation gap implies that, for a 1-percentage-point gap between expected and target inflation, the central bank raises the real interest rate by 68 basis points to bring inflation close to the target. In the same way, the estimated coefficient of the current account gap implies that a 1-percentage-point difference in this variable results in an increase of 61 basis points in the real interest rate. We also considered, as an alternative specification, a forward-looking version of the Taylor rule that includes, instead of the current account gap, the gap between the logarithm of GDP and the logarithm of its trend (measured using a Hodrick-Prescott filter). However, as can be seen in the second row of the panel, this measure of the output gap was not statistically significant, nor was the inflation gap in this specification.

We also tested for a nonlinear response of monetary policy to the inflation gap by introducing the square of the inflation gap as a separate regressor. However, its coefficient (fourth row of the bottom panel) was not statistically significant, and the coefficients on the inflation gap and the current account gap changed little. Finally, we also tested for asymmetries in the response of monetary policy. For this purpose we introduced a multiplicative dummy for those observations where the inflation gap was negative (fourteen out of thirty-eight observations in the second period), but again, as

Table 3. Estimates of the Central Bank of Chile Reaction Function[a]

Specification	Parameter						*J-test*	R^2
	ρ_1	ρ_2	α	β	γ_1	γ_2		
				Sample period 1985Q3 to 1989Q4				
Baseline	1.864 (43.54)	–1.037 (–19.67)	7.000 (18.97)	0.550 (3.26)			0.27	0.79
Adding output gap	1.436 (14.02)	–0.713 (–7.83)	4.960 (33.85)	0.560 (4.75)	1.400 (6.95)		0.24	0.87
Adding square of inflation gap	0.869 (9.89)	–0.005* (–0.04)	6.440 (7.41)	0.001* (0.005)	0.698 (3.32)	–0.520* (–1.022)	0.02	0.86
Adding dummy for negative inflation gap	1.161 (7.47)	–0.494 (–3.89)	5.225 (33.39)	0.324 (4.58)	1.461 (9.22)	0.163 (4.28)	0.20	0.88
				Sample period 1990Q1 to 1999Q4				
Baseline	1.219 (8.96)	–0.322 (–3.35)	6.540 (11.73)	1.440* (1.16)			0.06	0.83
Adding output gap	1.162 (12.55)	–0.325 (–3.5)	6.240 (24.99)	0.236* (1.28)	0.360* (1.11)		0.11	0.88
Adding current account deficit	0.726 (9.87)		6.827 (15.63)	0.676 (2.31)	0.610 (2.56)		0.05	0.80
Adding square of inflation gap	0.72 (9.99)		6.962 (10.76)	0.742 (2.21)	0.559 (2.57)	–0.066* (–0.41)	0.05	0.81
Adding dummy for negative inflation gap	0.699 (8.93)		7.018 (13.61)	0.675 (2.62)	0.581 (2.73)	–0.350* (–0.66)	0.04	0.77

a. In the regression equation, ρ_1 and ρ_2 are the coefficients on one- and two-period lags of the real interest rate, α is the constant term, β is the coefficient on the inflation gap, and γ_1 and γ_2 are coefficients on additional regressors as indicated in the table. Numbers in parentheses are t statistics.

* Not significant at the 10 percent level. All the other variables are significant at the 5 percent level.

reported in the bottom row of the table, the coefficient of the dummy variable was not statistically significant.

As a further test of the model, we also estimated it for the period before the central bank became independent. Because there was no explicit inflation target during this period, we used a forward-looking, four-quarter moving average of the annual inflation rate as the target. The results of these estimations appear in the top panel of table 3. The inflation gap by itself (in the baseline regression, shown in the top row) is statistically significant, as is the gap between the log of GDP and the log of its trend value (second row).

For this period also, we tested for the existence of asymmetries in the response of monetary policy. For this purpose we introduced a quadratic term of the inflation gap, and a multiplicative dummy for those periods when the inflation gap was negative. The coefficient of the nonlinear term turned out not to be statistically significant (third row of the top panel), but the coefficient of the dummy variable was statistically significant and had the expected sign (fourth row). That is, for a given size of the inflation gap, the monetary authority adjusts the interest rate by a larger amount when the gap is negative.

A first reading of these results could make them appear surprising, as they suggest that well before the central bank became independent it was already operating under rules that tried to keep inflation close to its forward-looking trend value. But this finding is also consistent with the view that the independence of the central bank, which was granted in 1989, only institutionalized procedures that were already in operation well before (Fontaine, 1991).

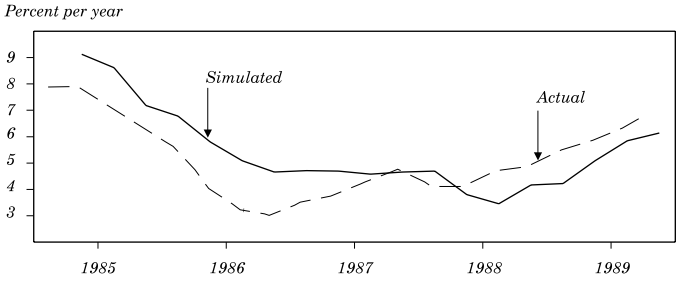
Returning to the results for the 1990s, another result that should be mentioned is the high persistence of the interest rate. This can be appreciated by calculating the sum of the two coefficients of the lagged values of the interest rate, which lies between 0.7 and 0.9. A value in this range implies that, for a given change in the target interest rate, the proportion that is reflected in the rate for the same quarter is between 10 and 30 percent of that change.

Because the central bank obtained its independence only in late 1989, we can investigate how the actual monetary policy followed before 1990 differed from what it would have been if monetary policy during that period had been governed by the reaction function of the second period. Figure 4 compares, for the period from 1985Q1 to 1989Q4, the actual and simulated values of the real interest rate. The latter were obtained using the second-period reaction function. The figure shows that, up to the first quarter of 1988, the fitted values were above the actual values, implying that during this period

monetary policy was more expansionary than it would have been under the policy of the second period. Thereafter the fitted values are below the actual values; this period was one where the central bank adopted a very tight monetary policy to slow down the acceleration of inflation (Corbo and Fischer, 1994).

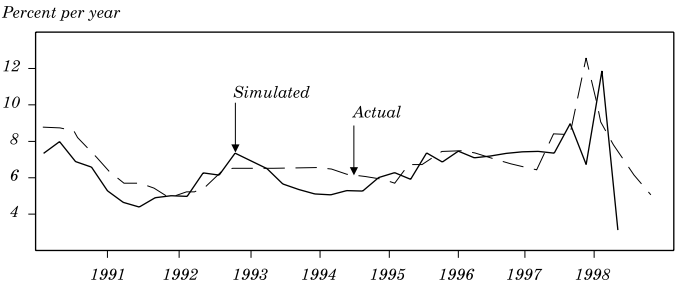
Figure 5 presents, for the second period, the fitted and actual values of the real interest rate. The fitted values were obtained using the equation reported in the third line in the bottom panel of table 3. The figure shows that the model tracks the actual rate quite closely.

Figure 4. Actual and Simulated Values for the Real Interest Rate in Chile 1985-89



Source: Author's calculations.

Figure 5. Actual and Simulated Values for the Real Interest Rate in Chile 1990-99



Source: Author's calculations.

The main exceptions are the period from 1994Q1 to 1995Q2, when the equation underestimates the actual values, and the end of the sample, when interest rates were set more to defend the exchange rate band than to achieve the inflation target.

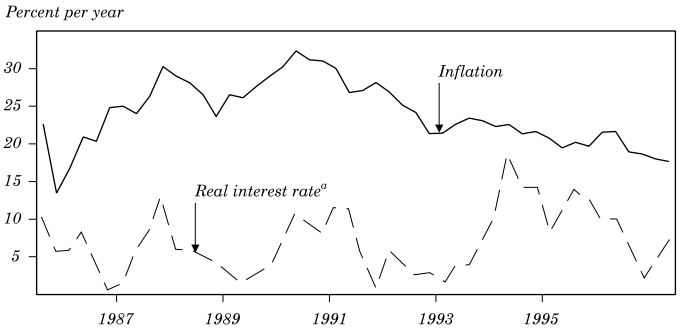
3.2 Colombia

As we saw in section 2, the crucial reform of monetary policy in Colombia took place in 1991. This was accomplished through a new constitution enhancing the legal independence of the central bank. This event provides a natural breakpoint in the sample period, in that one would expect, in general, different behavior before and after the central bank became independent. Before describing the estimation, in figure 6 we present the paths of inflation and of a three-quarter lag of the real interest rate.

The estimation uses quarterly data for the period from 1986Q1 to 1998Q4. In a first stage, a baseline reaction function was estimated using GMM, in which the only right-hand-side variable was the deviation of expected inflation from its trend, obtained as a Hodrick-Prescott filter of observed inflation. To account for the empirically observed smoothing of movements in short-term interest rates, we used a one-period partial adjustment model for the adjustment of the observed interest rate toward its desired level. The dependent variable was measured as the interest rate on certificates of deposit (CD), because it is through this instrument that the central bank carries out its monetary policy.

We started by estimating a reaction function for the whole period. The results of this estimation, using a two-quarter lead for the inflation gap, are shown in the top panel of table 4. The vector of instruments included one to four lags of the inflation gap, of the unemployment gap, and of short-term interest rates. The unemployment gap was measured as the deviation of the unemployment rate with respect to a trend value obtained using a Hodrick-Prescott filter. All the estimated coefficients were found to be statistically significant at the 1 percent level, with the exception of the inflation gap, which was significant only at the 10 percent level (the corresponding p-value is 0.065). The coefficient on the deviation of observed inflation from its target value is greater than one. This result suggests that the Central Bank of Colombia would have moved the interest rate aggressively in order to avoid a deviation of inflation from its target, defined here as a smooth trend of observed inflation.

Figure 6. Inflation and Lagged Real Interest Rate in Colombia.



Source: Authors' calculations.
a. The real interest rate is defined as the ex post difference between nominal interest rate and inflation. The rate is shown with a lag of three quarters.

Nonetheless, using a Wald test, the null hypothesis that $\beta = 1$ cannot be rejected at the 5 percent significance level. In other words, the data do not support "hawkish" behavior on the part of the Colombian authorities during the sample period as a whole. This is not surprising, because this period includes the second half of the 1980s, a period during which Colombia's monetary policy has usually been described as accommodative (Cárdenas and Partow, 1998). We confirm that monetary policy was accommodative in the sense that the central bank adopted a neutral position, accommodating expected shocks to inflation through monetary policy by holding the real interest rate constant.

The estimated coefficient on the partial adjustment process of the actual toward the desired interest rate level also shows that the Colombian authorities were reluctant to introduce abrupt changes in monetary policy. In particular, only one-fifth of a given desired adjustment in the interest rate was accomplished during one quarter.

In Colombia the only legal objective of the central bank other than monetary stability is the stability of the financial system. Therefore we proceeded directly to search for other, hidden objectives. These could be more important for the first half of the sample, when the central bank was not yet independent. Thus we proceeded to introduce other possible objectives of monetary policy as arguments in the reaction function. In particular, we added the

Table 4. Estimates of the Central Bank of Colombia Reaction Function[a]

Specification	*Parameter*					*J-test*	R^2
	ρ	α	β	γ_1	γ_2		
				Sample period 1986Q1 to 1998Q4			
Baseline	0.176 (3.61)	31.15 (22.11)	2.84* (1.89)			0.10	0.61
				Sample period 1986Q1 to 1990Q4			
Baseline	0.78 (14.21)	33 (357.3)	0.71 (11.4)			0.25	0.66
Adding unemployment gap	0.81 (15.9)	32.85 (427.22)	0.6 (14.1)	–7.85 (–2.53)		0.24	0.60
Adding real exchange rate	0.74 (17.24)	32.7 (870.51)	0.67 (16.3)	–7.46 (–3.21)	1.75 (2.34)	0.31	0.61
				Sample period 1991Q1 to 1998Q4			
Baseline	0.32 (3.41)	25.62 (22.56)	2.73 (4.37)			0.15	0.44
Adding unemployment gap	0.27 (5.2)	25.57 (13.94)	2.19 (2.43)	–32.86* (–1.82)		0.15	0.56

a. Parameters are as described in table 3 except that ρ is the partial adjustment parameter and the interest rate is the nominal instead of the real rate. Numbers in parentheses are *t* statistics.
* Significant at the 10 percent level. All the other variables are significant at the 5 percent level.

unemployment gap. As lagged values of the unemployment gap were already used as instruments in the estimation, introducing the unemployment gap as an additional regressor in the reaction function is equivalent to testing whether it enters as a separate objective of monetary policy. The unemployment gap was measured as the difference between the actual rate of unemployment and its quadratic trend.

This specification yielded poor results (not shown). The coefficient of the unemployment rate was either not statistically significant or had the wrong sign. Similar results were obtained when the deviation of the real exchange rate from its trend was introduced as an alternative variable (not shown). The lack of a satisfactory relationship to explain the responses of monetary policy to economic shocks during the whole sampling period (1986-98) may be due to the existence of a structural break. Such a break might have occurred in terms of the objective function of the central bank, as it gained legal independence only in the early 1990s, and the objective of price stability was only then introduced as its main priority. Or there may have been a change in the type of shocks that hit the economy: access to external financing improved significantly during the 1990s, when a broadly based reform program was put into practice. Thus we proceeded to separate the sample into two periods: 1986Q1 to1990Q4, and 1991Q1 to 1998Q4.

The results of the estimation for the first of these two periods are shown in the middle panel of table 4. As in the regressions for the whole period, we started by estimating a baseline equation in which only the deviations of the observed inflation from its trend—again obtained as a Hodrick-Prescott filter—entered as a regressor. The results show that all the variables are statistically significant at the 1 percent level and have the expected signs. The coefficient on the deviation of inflation from its (implicit) target is significantly less than one, suggesting that the Colombian authorities during this period tended to accommodate expected shocks to inflation, letting the real interest rate fall when a rise in future inflation was forecasted. The partial adjustment coefficient also shows that, during this period, movements in short-term interest rates showed less persistence than over the whole period. One must keep in mind, however, that the magnitude of the estimated partial adjustment coefficient for the whole period could be subject to some kind of specification error. In any case, the estimated coefficient for the period from 1986Q1 to 1990Q4 seems to be particularly high: almost four-fifths of the desired adjustment in the observed interest rate was achieved in one quarter.

We then introduced the unemployment gap as an additional regressor. The results of an estimation in which this variable enters the equation with a one-quarter lead are shown in the second row of the panel. All the coefficients are statistically significant at the 1 percent level (with the exception of the coefficient on the unemployment gap, which has a p-value of 0.02) and are very similar to those obtained under the baseline specification. Again the coefficient on the deviation of inflation from its target is significantly less than one. The coefficient on the unemployment gap suggests that, during this period, the monetary authorities also gave some weight to this variable as an additional objective. In particular, the results imply that the authorities reduced short-term interest rates when a rise in the gap between unemployment and its trend was expected, and increased rates when a fall in the gap was expected.

As a next step, we introduced the deviation of the real exchange rate from its trend as an additional variable to the above specification. The results, shown in the last row of the middle panel of table 4, are for a specification in which the deviation of the real exchange rate from its trend value enters the equation with a four-period lead. The instruments utilized include the first to the fourth lag of the deviation of inflation from its target, of the unemployment gap, of the short-term interest rate, and of the exchange rate variable. As the table shows, all the coefficients are statistically significant and have the expected sign. Excluding the coefficient on the real exchange rate variable itself, all the results are very similar to those obtained when the reaction function included only the inflation gap and the unemployment gap as arguments. As a test of the plausibility of this specification, one can estimate, under the assumption of a constant inflation target, the coefficient of the "long run" interest rate. The estimated value turns out to be 32.7 percent, which is very close to the average for the sample period (32.97 percent). The coefficient on the deviation of the real exchange rate from its trend suggests that the Colombian authorities were not just concerned about price stability and unemployment volatility. Rather, they also tried to stabilize expected movements in the real exchange rate, presumably to avoid putting the competitiveness of the tradable sector at risk.

As a final step we included the interest rate on three-month U.S. Treasury bills to the last specification, to investigate how

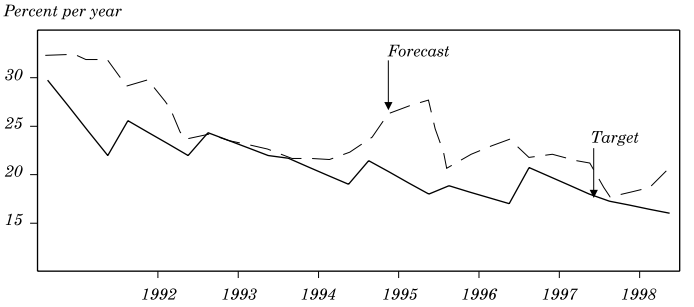
independent domestic monetary policy in Colombia was from the stance of foreign monetary policy. The results, not reported here, were very poor, which is not surprising in that, during the sample period (1986-90), Colombia was relatively closed to international capital movements.

Next we studied how monetary policy was conducted after the central bank became independent, by estimating a reaction function for the period from 1991Q1 to 1998Q4. During this period, under the law, the overriding objective of the central bank was to achieve monetary stability. In the transition toward monetary stability the central bank announced annual inflation targets. Thus for this period we define the inflation gap as the deviation of observed inflation from the (linearized) annual targets established by policymakers. The estimation of the baseline equation for this subperiod yielded the results shown in the bottom panel of table 4. The coefficient for the inflation gap, when this variable enters the equation with a two-period lead, is statistically significantly greater than one, which supports the idea that the authorities were determined to avoid deviations of observed inflation from its target. However, this does not necessarily imply that policymakers were hawkish; the observed result could well be explained by the setting of "soft" annual inflation targets. Indeed, if one compares an inflation forecast made with an autoregressive model with the announced target, one finds that only in 1995 was the inflation forecast a hard target (figure 7).

We next extended the arguments of the reaction function to include the unemployment gap. The results obtained when the unemployment gap enters the equation with four leads provide some (weak) evidence that the Colombian authorities considered unemployment stability as a final objective during the period of central bank independence. The coefficient on the unemployment gap is statistically significant at the 10 percent level (the corresponding p-value is 0.08). When the deviation of the real exchange rate from its trend was included as an additional argument in the reaction function (not shown), the results were very poor. Finally, as in the regressions for the first subperiod, the inclusion of the three-month U.S. treasury bill rate did not provide evidence that foreign monetary policy imposed a constraint on the Colombian authorities during the 1990s (results not shown).

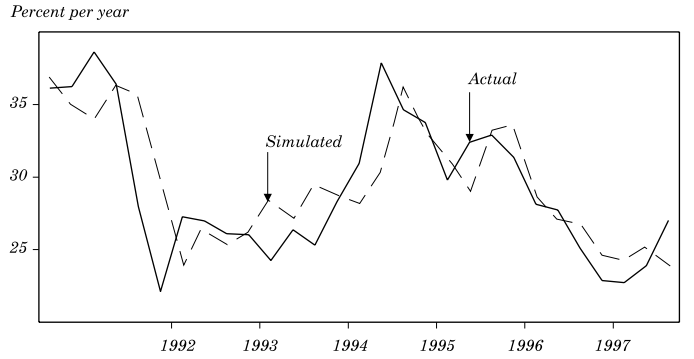
Figure 8 compares the paths of the observed and the predicted nominal interest rate in Colombia, where the latter is computed using the second regression equation in the bottom panel of table 4. As the figure shows, the model tracks the trajectory of the actual rate quite closely.

Figure 7. Inflation Targets and Inflation Forecasts in Colombia.



Source: Author's calculations.

Figure 8. Actual and Simulated Values for the Nominal Interest Rates in Colombia.



Source: Author's calculations.

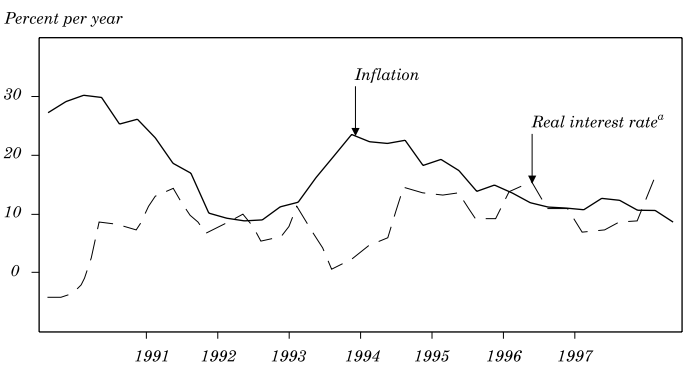
3.3 Costa Rica

As discussed in section 2, Costa Rica's central bank became independent only in 1995 and has, in addition to its main objective (the achievement of price stability), a secondary objective of achieving full employment. However, like its Chilean counterpart, the Central Bank of Costa Rica has been concerned with reducing inflation since before it became independent. Therefore we study the way in which the central bank has conducted monetary policy throughout the 1990s.

In Costa Rica monetary policy is carried out using what are called monetary stabilization bonds (whose abbreviation in Spanish is BEM). These have a typical maturity of six months, and therefore the six-month interest rate of the BEM is used as the interest rate intervention variable in the estimation of a reaction function. The trajectories of inflation and of the real interest rate lagged three quarters are presented in figure 9. Some evidence emerges that the central bank adjusted interest rates so as to affect the future course of inflation.

As in the other countries, we used a one-period partial adjustment mechanism for the adjustment of the actual interest rate toward its desired level. Also, because Costa Rica does not have an explicit inflation

Figure 9. Inflation and Lagged Real Interest Rate in Costa Rica



Source: Author's calculations.
a. The real interest rate is defined as the ex post difference between nominal interest rate and inflation. The rate is shown with a lag of three quarters.

targeting framework, the target inflation rate is unknown, and we assume that the objective was to keep inflation around its trend value. The latter is measured using a Hodrick-Prescott filter. Alternatively, we could have followed Clarida, Galí, and Gertler (1998b) and assumed that the inflation target is a constant, which can then be estimated from the constant of the regression. However, this procedure could introduce a specification error in cases when the country is pursuing the objective of reducing inflation gradually toward a long-run steady-state level.

The reaction function for Costa Rica is estimated using quarterly data for the period from 1990Q1 to 1998Q4. The results of estimation of a baseline equation, which includes only the inflation gap as an explanatory variable, are presented in the first row of table 5. The inflation gap is measured using a two-quarter lead, and the equation is again estimated using GMM. The instruments used are four lags of the inflation gap, of the BEM interest rate, and of the output gap.

As can be observed from the table, the coefficient on the inflation gap in the baseline specification is positive and greater than one. Thus it appears that the Central Bank of Costa Rica was trying to keep inflation close to its trend, reacting to a 1-percentage-point increase in the gap between expected inflation and its trend with a 47-basis-point increase in the real interest rate. Nonetheless, as in the Colombian case, the estimated parameter of the inflation gap is not significantly different from one. Thus policymakers could well have in fact been neutral in the face of expected inflation shocks.

The low value of the partial adjustment coefficient shows that interest rates have a lot of persistence, moving very slowly toward their desired value. The persistence of interest rate movements is of the same order of magnitude as in the Colombian case. Finally, as an indicator of the validity of the model, the estimated value of the "long run" nominal interest rate turns out to be 22.8 percent, very close to the mean of the interest rate series over the sampling period (24.95 percent).

The results obtained so far could be subject to a specification error, because the Central Bank of Costa Rica has other objectives besides achieving a gradual reduction of inflation. Therefore we also considered the addition of other variables that appear as legal objectives of the central bank. As mentioned in section 2, the Central Bank of Costa Rica's charter establishes several secondary objectives for

Table 5. Estimates of the Central Bank of Costa Rica Reaction Function[a]

Specification	*Parameter*					*J-test*	R^2
	ρ	α	β	γ_1	γ_2		
	Sample period 1990Q1 to 1998Q4						
Baseline	0.38	22.80	1.47			0.15	0.61
	(4.4)	(24.4)	(5.68)				
Adding output gap	0.68	25.49	0.79	73.77		0.21	0.61
	(15.9)	(43.48)	(10.89)	(7.54)			
Adding real exchange rate	0.64	25.59	0.82	58.85	60.29*	0.22	0.61
	(11.49)	(92.88)	(32.31)	(9.60)	(2.49)		

a. Parameters are as described in table 3 except that ρ is the partial adjustment parameter and the interest rate is the nominal instead of the real rate. Numbers in parentheses are *t* statistics.
* Significant at the 5 percent level. All the other variables are significant at the 1 percent level.

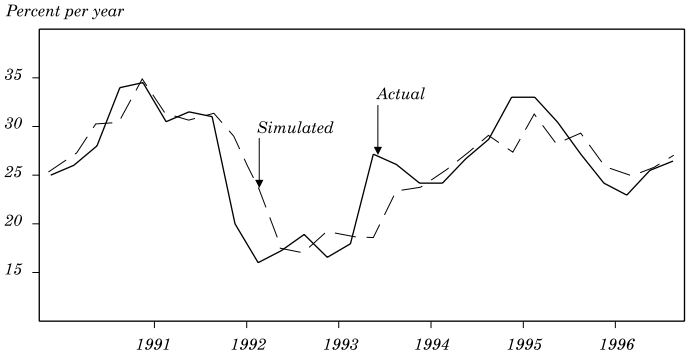
monetary policy. These include the achievement of full employment, the promotion of efficiency in the internal and external payments systems, the appropriate management of international reserves, and the stability of the financial system. The only one of these objectives that could play an independent role is the full employment objective. To account for this objective we introduced the output gap as an additional explanatory variable. This was measured as the deviation of an industrial output index from its trend, the latter obtained using a Hodrick-Prescott filter. Thus we estimated a sort of forward-looking version of the Taylor rule. In this specification the inflation gap enters the equation with a two-period lead and the output gap with an eight-period lead.[14] It appears from the results (second row of table 5) that the monetary authorities did try to stabilize output over the sample period. Another interesting finding is that, in this second specification, the coefficient on the inflation gap falls to less than one. A Wald test confirms that the coefficient is significantly less than one, suggesting that during the 1990s the authorities accommodated expected shocks to inflation.

To introduce the objective of promoting efficiency of the internal and external payments system, we added to the above specification the expected deviation of the real exchange rate from its trend. The new variable enters the equation with an eight-period lead. The results (shown in the third row of table 5) show that the stabilization of the real exchange rate was also considered as a separate objective by the Costa Rican authorities. Again the inflation gap coefficient is statistically significantly less that one, confirming the finding that the monetary authorities followed an accommodative policy with respect to shocks to expected inflation. We also introduced as a separate argument the level of foreign reserves, but the results, not reported here, were very poor. Finally, we also considered the six-month U.S. Treasury bill rate as another variable that might have played a role in setting monetary policy, but the results were also very poor.

Figure 10 compares the paths of the actual and estimated values of the interest rate, the latter obtained from the last equation in table 5. As the figure shows, with the exception of 1992, the model tracks the behavior of the observed interest rate fairly closely.

14. The lead utilized for the output gap is much longer that one would have expected a priori, as monetary policy works in emerging market countries with a much shorter lag than in industrial countries (Fry and others, 1999).

Figure 10. Actual and Simulated Values for the Nominal Interest Rate in Costa Rica



Source: Author's calculations.

3.4 El Salvador

In El Salvador the main objective of the central bank is price stability. A secondary objective, as noted in section 2, is to ensure the stability and competitiveness of the financial system. However, in setting monetary policy, El Salvador uses a framework closer to a fixed exchange rate: the exchange rate has been de facto fixed since the early 1990s. El Salvador also allows the free movement of capital and therefore comes close to the textbook model of a fixed exchange rate with perfect capital mobility. In this Mundell type of setting, monetary policy has no role to play in stabilization, and therefore the exercise of estimating a reaction function for monetary policy would appear to make no sense. Nonetheless, it may be claimed that capital mobility in El Salvador is far from perfect, and consequently, it should be worthwhile to analyze the extent to which policymakers have room to conduct an independent monetary policy. Indeed, a similar point is made by Clarida, Galí, and Gertler (1998b), who study the reaction functions for France, Italy, and the United Kingdom at a time when these three countries fixed their currencies within the Exchange Rate Mechanism (ERM) of the European Monetary System.[15] In their framework the stance of monetary

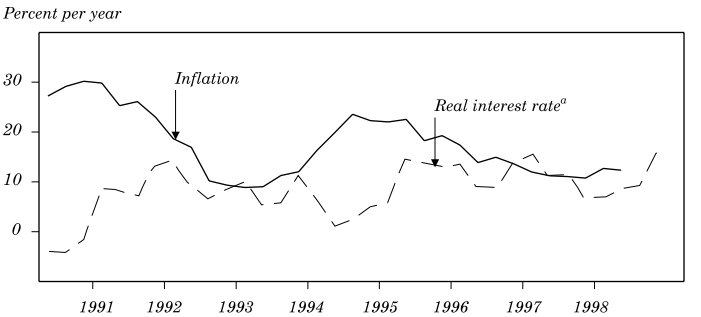
15. Clarida, Galí, and Gertler (1998b) assess the degree of independence of monetary policy for the members of the ERM by adding the Bundesbank policy rate to a baseline specification for the reaction function that includes only domestic variables.

policy is a weighted average of the interest rate desired by the authorities and the foreign interest rate. In the context of El Salvador, an analogous exercise can be performed by adding to a baseline specification the interest rate on U.S. Treasury bills as a measure of the external constraints faced by the Salvadorian monetary authorities.

As in the case of the other countries, we proceeded to estimate a baseline specification in which monetary policy reacts only to expected future deviations of inflation from its trend. Then we added the foreign interest rate as a separate regressor. Thus two explanatory variables entered the extended model: the inflation gap and the six-month U.S. Treasury bill rate. For the dependent variable we used the financial system deposit rate. Figure 11 shows the trajectory of the inflation rate and of the real interest rate lagged three quarters. There is some evidence that interest rate adjustment is related to the inflation rate. In the estimation, as in the case of the other countries, we assumed a first-order partial adjustment process for the adjustment of the domestic interest rate. The estimations were carried out using quarterly data for the period 1991Q1 to 1998Q4. The results appear in the top row of table 6. The coefficient on the U.S. Treasury bill (γ_2) is not statistically significant, implying that foreign monetary policy was not an effective constraint on the conduct of monetary policy in El Salvador.

Given this finding, we focused on estimating a reaction function for the Central Bank of El Salvador in the same way as we did for the other countries of the sample. The second line of table 6 presents the results from estimation of a baseline specification in which only the

Figure 11. Inflation and Lagged Real Interest Rate in El Salvador



Source: Author's calculations.
a. The real interest rate is defined as the ex post difference between nominal interest rate and inflation. The rate is shown with a lag of three quarters.

Table 6. Estimates of the Central Bank of El Salvador Reaction Function[a]

Specification	*Parameter*					*J-test*	R^2
	ρ	α	β	γ_1	γ_2		
	Sample period 1991Q1 to 1998Q4						
Baseline plus U.S. Treasury bill rate	0.06	10.07	0.98*		0.05**	0.12	0.92
	(2.4)	(2.52)	(1.84)		(1.1)		
Baseline	0.09	14.05	1.11			0.10	0.91
	(2.62)	(22.8)	(2.34)				
Adding output gap	0.06	13.49	1.39	3.72*		0.10	0.93
	(2.26)	(18.8)	(2.1)	(1.92)			

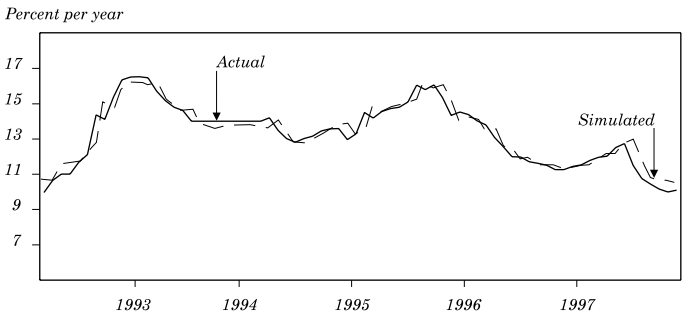
a. Parameters are as described in table 3 except that ρ is the partial adjustment parameter and the interest rate is the nominal instead of the real rate. Numbers in parentheses are *t* statistics.
* Significant at the 10 percent level.
** *Not* significant at the 10 percent level. All the other variables are significant at the 5 percent level.

six-month-forward inflation gap enters as an explanatory variable. The instruments considered included one to four lags of the inflation gap, the output gap, and the short-term (six-month) interest rate. All the coefficients are statistically significant and have the expected signs (second row of table 6). The coefficient for the inflation gap is slightly greater than one, but a Wald test confirms that it is not statistically different from one. This result suggests that monetary authorities were not particularly determined to control inflation shocks; policymakers would have let the real interest rate remain constant when faced with shocks to inflation. Another interesting result is given by the partial adjustment coefficient. Over 90 percent of the current short-term interest rate is explained by the lagged interest rate, reflecting a high degree of persistence in interest rate movements.

We then proceeded to add other variables as regressors in the reaction function. First, we introduced the output gap to find out whether the monetary authorities considered output stability as a final objective. We found (bottom row of table 6) that policymakers had at least some concern about output stability during the 1990s. The output gap appears to be significant at the 10 percent level and almost significant at the 5 percent level (the p-value is 5.9 percent). When we added the real exchange rate as another regressor, either in addition to the output gap or as an alternative to it, we found that it did not enter the reaction function of the Salvadorian authorities (results not shown).

Finally, figure 12 shows the paths of the observed and fitted values of the nominal interest rate, where the latter was obtained using the model reported in the last row of table 6. The model tracks the trajectory of the observed interest rate quite well.

Figure 12. Actual and Simulated Values for the Interest Rate in El Salvador



Source: Author's calculations.

3.5 Peru

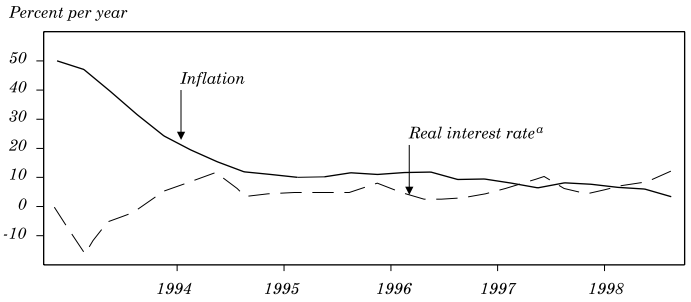
In Peru the 1980s were characterized by substantial macroeconomic disequilibria and financial repression, including interest rate controls. During the 1990s, however, substantial progress was made in restoring macroeconomic stability. As we saw in section 2, in January 1993 a new legal framework was introduced giving more independence to the central bank and making price stability the central bank's only objective.

In carrying out monetary policy, the Peruvian authorities have used the rate of growth of the monetary base as an intermediate target. The main instrument used to pursue this policy has been certificates of deposits of the central bank, which are bought and sold in open market operations. To investigate how monetary policy is carried out in Peru, we estimated reaction functions with quarterly data for the period from 1993Q1 to 1999Q1, the period of increased legal independence for the central bank. In a first stage we used the rate of change in the monetary base as the dependent variable. The results with this dependent variable were very poor, however, and therefore we switched to using the nominal interest rate on thirty-day certificates of deposit as the dependent variable.[16] Figure 13, which presents the paths of the real interest rate, with an four-period lag, and the rate of inflation, indicates that nominal interest rates were adjusted in response to inflation.

As in the other countries, we began by estimating a baseline specification in which the only regressor is the inflation gap. Given that Peru did not have an explicit inflation target, the inflation gap is defined as the difference between observed inflation and its trend, which is measured using a Hodrick-Prescott filter. Nonetheless, the estimation yielded poor results: the inflation gap either was not statistically significant or had the wrong sign. The same result was obtained when the trend of inflation was measured using a four-quarter moving average of quarter-to-quarter inflation rates. However, a stable relation was found when the inflation gap entered the equation as the difference between observed inflation and the average inflation rate for the sample period or, equivalently, when the target inflation rate was assumed to be a constant. The results of the estimation using this specification are reported in the first row of table 7. Here the

16. This series presented a problem of missing observations for March and May 1997. To overcome this problem, a least squares regression was estimated in which the certificate rate was regressed on its first lag and the discount rate. A first-order partial adjustment model was assumed and was supported by data.

Figure 13. Inflation and Lagged Real Interest Rate in Peru



Source: Author's calculations.
a. The real interest rate is defined as the ex post difference between nominal interest rate and inflation. The rate is shown with a lag of three quarters.

inflation gap enters the equation with a four-period (one year) lead, and the vector of instruments used in the estimation includes one to four lags of inflation, of the output gap, and of the short-term interest rate. The results show that monetary policy appears to have accommodated shocks to expected inflation. The coefficient of the inflation gap is also statistically significantly less than one. The estimated parameter of the partial adjustment process for interest rates implies a high degree of persistence of monetary policy: over 70 percent of the level of the short-term interest rate is explained by its lagged value.

As noted in section 2, the charter of the Central Reserve Bank of Peru establishes monetary stability as the only objective of monetary policy. Therefore one could conclude from these results that the monetary authority has not been fully committed to its legal objective.

In the next stage we added the output gap to the baseline equation. This variable, with a two-period lead, is statistically significant at the 1 percent level (second row of table 7). Again the coefficient of the inflation gap is significantly less that one, pointing to accommodative behavior on the part of the authorities. Finally, the deviation of the real exchange rate from its trend was introduced as a third regressor. This variable, too, is statistically significant at the 1 percent level (last row of table 7). This suggests that, during the sample period, Peruvian policymakers were concerned not only with output stability but also with the stability of the real exchange rate. Thus, despite the mandate to achieve price stability, other macroeconomic considerations also appear to have had a bearing on the course of monetary policy.

Table 7. Estimates of the Central Bank of Peru Reaction Function[a]

Specification	*Parameter* ρ	α	β	γ_1	γ_2	*J-test*	R^2
			Sample period 1993Q1 to 1999Q1				
Baseline	0.29	28.72	0.75			0.27	0.72
	(10.18)	(42.81)	(10.81)				
Adding output gap	0.26	28.25	0.73	23.93		0.27	0.73
	(5.34)	(46.00)	(14.95)	(3.04)			
Adding real exchange rate	0.28	28.00	0.65	4.52	73.29	0.30	0.76
	(30.33)	(126.6)	(25.62)	(3.92)	(12.66)		

a. Parameters are as described in table 3 except that ρ is the partial adjustment parameter and the interest rate is the nominal instead of the real rate. Numbers in parentheses are *t* statistics. All variables are significant at the 1 percent level.

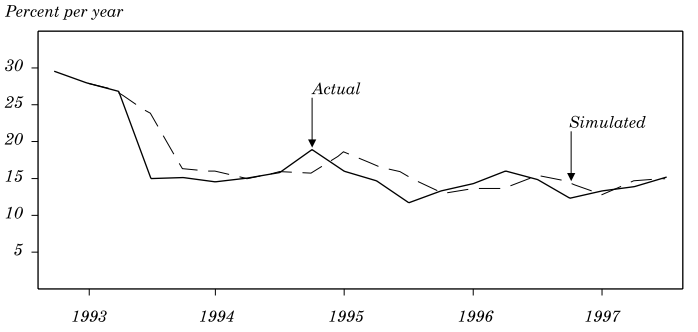
Finally, figure 14 shows the paths of the actual and fitted nominal interest rates, where the latter is obtained using the last equation in table 7. The model tracks the trajectory of the actual rate fairly closely.

To sum up the empirical findings, in two of the five cases studied (Chile and Colombia), monetary policy has clearly been geared, since the central bank gained independence, toward moving inflation closer to its target value. In El Salvador there is some evidence that monetary policy is at least neutral; that is, shocks to the inflation rate do not result in a change in the real interest rate. In the other two countries (Costa Rica and Peru), however, a higher real interest rate is not the mechanism utilized to bring inflation close to its target.

Of the five countries, Chile has made the most progress in reducing inflation toward its target level and in achieving a level of inflation close to those in the industrial countries. This is not surprising, because progress in reducing inflation depends on factors other than just monetary policy. Among these, one should consider the evolution of the equilibrium real exchange rate and the trajectory of imported inflation.

Finally, one can compare our results with results obtained by others for industrial countries. The most direct comparison can be made with the results of Clarida, Galí, and Gertler (1998b). In their empirical work, they find that interest rate policy in Germany, Japan, and the United States is mostly determined by the expected

Figure 14. Actual and Simulated Values of the Nominal Interest Rate in Peru



Source: Authors' calculations.

inflation gap, measured as the difference between expected inflation and a constant steady-state inflation target. These authors find that the real interest rate increases in response to shocks to expected inflation ($\beta > 1$ in their framework, where the dependent variable is the nominal interest rate). In contrast, the output gap was significant only for Germany and Japan and not for the United States. Thus, for the United States, the output gap is used only to get a forecast of future inflation. In our empirical results we found that, in Chile and Colombia, the output gap and the unemployment gap, respectively, were not statistically significant in the reaction function, and therefore did not play a role beyond the information they provide in forecasting future inflation.

For the smaller countries—Costa Rica, El Salvador, and Peru—our results show that foreign interest rates do not play an important role in setting the stance of monetary policy. For El Salvador this result is surprising, inasmuch as the nominal exchange rate did not change much during the 1990s, with its central bank using a combination of a money and an exchange rate anchor.

4. Conclusions

After a long tradition of high fiscal deficits and high inflation, Latin America made a major effort during the last decade to achieve a sustainable reduction of inflation. These efforts have paid off: whereas the average annual inflation rate in Latin America in the 1980s exceeded 100 percent, by 1999 annual inflation in the region was down to the single-digit level. Inflation strategies were initially based on getting the fiscal situation under control, as a way of liberating monetary policy from the need to finance fiscal deficits; since then strategies have moved to more formal uses of nominal anchors. The choice of a nominal anchor as the cornerstone of the stabilization effort has changed over time, as rigid exchange rate mechanisms have been replaced by more flexible arrangements. The exceptions are Argentina's currency board and the de facto fixed exchange rate arrangement of El Salvador. The other countries use either a monetary anchor or an inflation target.

To facilitate the reduction of inflation, and as a way of protecting the central bank from the political pressures that typically give rise to time-inconsistency problems, most Latin American countries have now granted their central banks independence. Central banks

in the region have also been given a clear mandate to achieve a sustainable reduction in inflation and appropriate instruments for doing so.

Although the results in terms of inflation reduction have been spectacular, the costs in terms of output are not in evidence. This result could be due, in large part, to the effect of the credibility of the new policies on inflation expectations, allowing inflation to be reduced at a much lower cost than anticipated from standard models with high inflation inertia. Moreover, the beneficial effect on growth is not surprising, as most studies of the costs of inflation show that these costs are highly nonlinear and become very high at high levels of inflation, such as those typical of Latin America in the 1980s.

In general, it is found that, in setting monetary policy, central banks look beyond just inflation to take into account other variables, which often are spelled out in their charter. These other variables are considered not because of their predictive power for expected inflation but as separate objectives of monetary policy. Thus, in the case of Chile, we found that the ratio of the current account deficit to GDP is also taken into account in deciding the stance of monetary policy. In contrast, the output gap was significant only in the second half of the 1980s, and not in the 1990s after the central bank became independent. A similar result is found for Colombia, where the unemployment rate is significant only in the 1980s and not in the 1990s. In Costa Rica and Peru, both the output gap and the real exchange rate are statistically significant, whereas in El Salvador only the output gap is statistically significant. Of the five countries, Chile has made the most progress in reducing inflation toward its target level and in achieving a level of inflation close to those in industrial countries. This is not surprising, because progress in reducing inflation depends on factors other than monetary policy alone. Among these, one should consider the path of the equilibrium real exchange rate and the trajectory of imported inflation.

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