FABIA A. DE CARVALHO
MAURÍCIO S. BUGARIN

Inflation Expectations in Latin America

In economies with important price indexation mechanisms, one of the greatest challenges of a disinflationary monetary policy is to make price setters form expectations (and thus set prices) on the basis of forward-looking variables instead of looking back into the past. Under a credible inflation-targeting regime, looking forward means believing in the inflation targets announced by the central bank.

Some Latin American central banks that explicitly target inflation have reacted strongly to deviations of inflation expectations from announced targets. Fraga, Goldfajn, and Minella argue that the strong reaction of the Central Bank of Brazil to private inflation forecasts suggests that "the Central Bank conducts monetary policy on a forward-looking basis and responds to inflationary pressures."[1] In Mexico, Torres García also finds evidence that monetary policy responds to forward-looking variables, such as inflation expectations, rather than to backward-looking ones.[2]

The literature on optimal monetary policy has traditionally been built on the assumption that agents' expectations are rational, which implies that price setters perfectly know the structure of the model governing the economy and all the parameters of that model.[3] However, this assumption is not innocuous to optimal monetary policy. Orphanides and Williams demonstrate that when expectations are updated every period from a finite sample regression, which seems to be what real-life econometricians do, the central bank should react

Carvalho is with the Central Bank of Brazil and the University of Brasília; Bugarin is with Ibmec São Paulo.

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1. Fraga, Goldfajn, and Minella (2003, p. 20).
2. Torres García (2002).
3. Evans and Honkapohja (2001, p.12).

more strongly to deviations of expectations from the desired inflation path than under rational expectations.[4] Evans and Honkapohja, as well as Woodford, also show that some particular forms of monetary policy rules cause instability in a macroeconomic system if forecasters learn over time instead of being unboundedly rational.[5]

Given the importance of inflation expectations to monetary policy decisions, it is crucial to identify the rationality embedded in the forecasts to which central banks react. One of the main purposes of inflation-targeting regimes is to anchor inflation expectations; understanding how these targets feed into the expectations' formation rule is therefore also relevant. Should inflation targets cease to be an anchor for inflation expectations, inflation stabilization costs would be higher.

This paper tests the rationality of private inflation forecasts surveyed by the University of Chile, the Central Bank of Brazil, the Bank of Mexico, and Infosel (a Mexican news agency).[6] The central banks of Brazil, Chile, and Mexico consider these surveyed forecasts in their inflation reports and, to varying degrees, see them as important indicators of future inflationary pressures. The results we obtain provide very strong evidence that private inflation forecasts in Brazil, Chile, and Mexico are unbiased, although this conclusion can be sensitive to the econometric technique employed.

In Chile, if we allow for serial correlation in the errors, reported forecasts for twelve-month-ahead inflation are also efficient in the use of relevant macro-

4. Orphanides and Williams (2002).

5. Evans and Honkapohja (2002); Woodford (2003).

6. We could have chosen to test the rationality of inflation forecasts embedded in financial instruments. The best choice of instruments in the Brazilian case would be interest rate swaps, while in Chile and Mexico it would be government bonds. As Söderlind and Svensson (1997) argue, however, the literature on extracting inflation expectations from financial instruments is grounded on the assumption that the forward term premium is at least constant, if not negligible. They also argue that "ideally one should use instruments with high liquidity, with insignificant credit risk, and without distorting tax treatment." These conditions are not met in the countries we investigate here. For instance, the risk premium in the yield curve of interest rate swaps in Brazil is not negligible and varies over time (Tabak and Andrade 2001). If we had chosen to use Brazilian government instruments, we would have been faced with issues of liquidity, policy interventions, and other specific government-related problems that would increase the volatility to the risk premium over and above the premium already present in market instruments. In Chile, the changing share of government securities denominated in pesos and indexed to consumer price index (CPI) inflation, recent innovations in the government securities market, and the fact that interest on securities is taxed provide sufficient reasons to be cautious about attempting to extract inflation expectations from these instruments. For a more comprehensive study on the evolution of CPI-linked debt in Chile, please see IMF (2004). We are unaware of any study along the lines of Tabak and Andrade (2001) for the Chilean and Mexican cases.

economic variables. In Brazil and Mexico, at least one macroeconomic variable could be better used to improve the accuracy of private inflation forecasts, which suggests that the economic model governing the inflation dynamics in these countries is not entirely understood.

In Mexico, we find strong evidence of inefficiency in the use of overnight and twenty-eight-day interbank interest rates for all forecasting horizons investigated. Our immediate candidate to explain this inefficiency is the choice of monetary policy instrument. Contrary to most inflation-targeting countries in the world, the Bank of Mexico's operational instrument is the monetary base rather than interest rates.

In Brazil, efficiency tests are highly sensitive to the econometric technique employed and the forecasting horizon analyzed. Median twelve-month-ahead forecasts are, in fact, efficient in the use of information on wholesale price inflation and the exchange rate. This suggests that the median forecaster understands the long-term effects of supply shocks on inflation. However, median short-term forecasts (namely, three and six months ahead) do not use such information efficiently. As is standard in inflation-targeting regimes, monetary policy in Brazil does not attempt to offset the first-round effects of supply shocks to inflation, which could cause some volatility of short-term inflation and thus increase uncertainty as to its short-term behavior.

The effect of demand conditions on inflation, however, is best understood for short-term horizons. Median forecasts for inflation three and six months ahead efficiently use the output gap, whereas twelve-month-ahead inflation forecasts do not.

The results of efficiency tests using panel data regressions are much less favorable. Even when we apply Keane and Runkle's covariance matrix to reduce the effect of shocks that hit forecasters alike, the Brazilian panel was not efficient in the use of any information available to forecasters.[7] As the survey is composed of professional forecasters, it cannot be ruled out that in the analyzed period people had not reached a consensus on what the Brazilian inflation dynamics actually were, and that alone might have had important implications for monetary policy.

The paper also investigates the formation rule of inflation expectations in the three selected countries. It presents evidence that inflation targets have been anchoring inflation expectations in all three economies. We also find evidence, however, of an important adaptive behavior in the formation of inflation expectations for a twelve-month-ahead horizon. This implies that

7. Keane and Runkle (1990).

credibility would be enhanced if monetary policy could affect inflation within a range of less than twelve months, as is the case in Brazil.

In Brazil, the targets were entirely disregarded in the formation of inflation forecasts for part of 2002 and 2003. We argue that granting legal autonomy to the central bank could enhance credibility in the Brazilian case. In a companion paper, we show that a higher dispersion in central bankers' preferences causes strong central bankers to be tougher in their inflation choices so as to signal their type to society.[8] In other words, disinflation policies will be costly in countries where individuals have very different beliefs and preferences for monetary policy. A mechanism that forced the convergence of central bankers' policies would therefore lower inflation stabilization costs.

Formal autonomy implies increased separation of political parties' ideologies from the central bank's conduct. We thus expect that a mix of formal autonomy, explicit and clear targets for the Central Bank of Brazil, and preemptive breach of contract clauses would lead to a convergence of different central bankers' behavior to a policy that conforms to one particular inflation-output preference. We argue that the absence of this mix in Brazil may have caused the strong misalignment of inflation forecasts from inflation targets after mid-2002.

The paper is organized as follows. The next section presents the results of rationality tests for Brazil, Chile, and Mexico. The paper then identifies the formation rule of inflation expectations in these countries and discusses the role of inflation targets in forecasters' behavior. The last section concludes the paper.

The Rationality of Inflation Expectations in Latin America

Most of the literature using standard rationality tests claims to follow Muth's description of unboundedly rational behavior, which implies that price setters have full knowledge of the structure of the model governing the economy and know all the parameters of that model.[9] These rationality tests assume that forecasters attribute symmetric weights to their forecast errors, and they thus do their best to make unbiased and efficient projections.

Unbiased expectations in this literature fulfill the test, H_0: $\alpha = 0$ and $\beta = 1$, in the model

$$\pi_{t+k} = \alpha + \beta E_t \pi_{t+k} + \mu_{t+k}, \tag{1}$$

8. Bugarin and Carvalho (2005).
9. Muth (1961); Evans and Honkapohja (2001, p.12).

or, more restrictively, H_0: $\varphi = 0$ in the model

(2) $$_t\varepsilon_{t+k} = \varphi + \eta_{t+k},$$

where α, β, and φ are the model's parameters; π_{t+k} is inflation realized at $t + k$, with $k \geq 0$; $E_t\pi_{t+k}$ is inflation forecast for $t + k$ based on information available at time t; $_t\varepsilon_{t+k} = E_t\pi_{t+k} - \pi_{t+k}$ is the forecast error; and μ_{t+k} and η_{t+k} are shocks.

Rational expectations are not only unbiased, but also efficient. Efficient forecasts make use of all relevant information available to the forecaster at the time the prediction is made. In other words, any information in the forecaster's information set, Θ, should be orthogonal to the forecast error. This implies that H_0: $\alpha = 0$, $\beta = 1$, and $\gamma = 0$ in the model

(3) $$\pi_{t+k} = \alpha + \beta E_t\pi_{t+k} + \Theta_t\gamma + \mu_{t+k},$$

or, more restrictively, H_0: $\varphi = \lambda = 0$ in the model

(4) $$_t\varepsilon_{t+k} = \varphi + \Theta_t\lambda + \eta_{t+k},$$

where γ and λ are the model's parameters.[10]

There is reason to suspect that inflation forecasts used as regressors in the estimations of the models specified in equations 1 and 3 will be partly endogenous. Endogeneity might arise here because of the omitted variables problem or measurement error. If one believes that the best description of the inflation dynamics is a Phillips curve, in which, in addition to inflation expectations, there are other important explanatory variables such as the output gap, the model tested in this paper would present the omitted variables problem. In addition, the theoretical model of rationality refers to inflation expectations, to which inflation forecasts, as used in this paper, are only a proxy. If one assumes that inflation forecasts are actually the sum of true inflation expectations and a measurement error, ordinary least squares (OLS) estimations are inconsistent. In any case, the endogeneity that arises should be controlled for with instrumental variables.

Fildes and Stekler report that the results of rationality tests that use U.S. and U.K. data are sensitive to the econometric technique employed, the assumption

10. A number of authors use the efficiency and unbiasedness criteria as employed here, to test the rationality of market forecasts. Examples include Marimon and Sunder (1993) and Keane and Runkle (1990). As Fildes and Stekler (2002) note, not rejecting the joint hypotheses using equations 1 and 3 is a sufficient, but not a necessary, condition for rationality. They argue, however, that equations 2 and 4 are "a more restrictive condition" and that "the rejection of these rationality tests suggests that forecasts might have been improved."

regarding the stochastic process generating the random variables, and the presence of unit roots.[11] We find that this is also true for some Latin American economies. Nonetheless, we do not report the results of rationality tests with differenced series, which would be advisable in the presence of unit roots. Although we cannot reject the null of unit roots in several of the series used in this study (see table 1), the robustness of unit root tests is highly questionable when the time series is not very long, as is the case here. In addition, the presence of unit roots in inflation or inflation forecasts may simply be suggesting that in the period considered in this study, some economies were going through either disinflationary processes or adjustment to shocks. Neither of these cases should imply that the trend will remain.

The following subsections report the results of rationality tests carried out using survey responses in Brazil, Chile, and Mexico. These countries have been conducting their own inflation expectations surveys for quite a reasonable length of time. Argentina, Colombia, Costa Rica, Peru, and Uruguay also have their own inflation expectations surveys, but (with the exception of Colombia) the available time series is too short to allow for reliable inference.

Rationality in Brazil

The Central Bank of Brazil adopted a formal inflation-targeting regime in June 1999, a few months after floating the exchange rate. The operational instrument used to achieve inflation targets has always been the benchmark overnight nominal interest rate (SELIC).

The Central Bank's Investor Relations Office (IRO) has been surveying professional forecasters' inflation expectations since June 1999.[12] Until July 2001, the IRO surveyed inflation forecasts only for short-term horizons and for December of each year. After November 2001, the survey began to be operationally implemented through a secure website where institutions input their forecasts for a varying set of forecasting horizons. The number of participants in the survey increased substantially to over a hundred, although only about eighty are regular suppliers of inflation forecasts. Among those, around 84 percent are chief economists of financial institutions, 12 percent are senior analysts of economic consulting firms, and 4 percent are senior economists of real sector companies.

11. Fildes and Stekler (2002). Using the same data but distinct estimation techniques, for instance, Zarnowitz (1985), Keane and Runkle (1990), and Davies and Lahiri (1999) all reach different conclusions about the rationality of inflation forecasts in the United States.

12. For a comprehensive description of the survey, see Marques, Fachada, and Cavalcanti (2003).

TABLE 1. Augmented Dickey-Fuller Unit Root Tests Including a Trend[a]

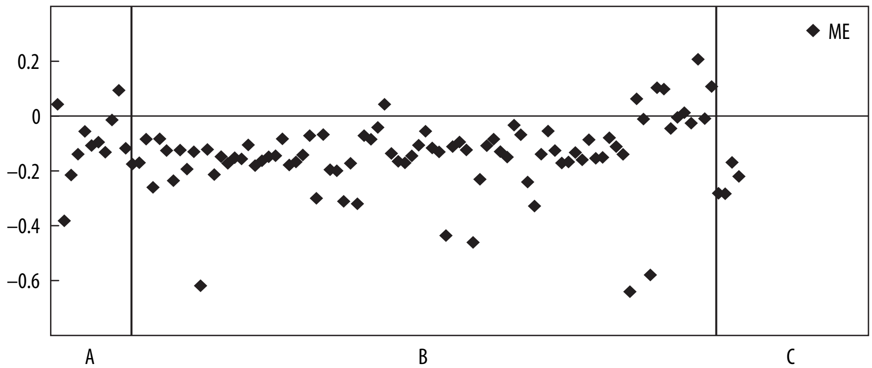
Chile		*Mexico*		*Brazil*	
Variable tested	*Mackinnon approximate p value*	*Variable tested*	*Mackinnon approximate p value*	*Variable tested*	*Mackinnon approximate p value*
$E_t \pi_{t+12}$	0.64	$E_t \pi_{t+12}$ (Banxico)	0.98	$E_t \pi_{t+12}$	0.82
$E_t \pi_{t+24}$	0.20	$E_t \pi_{t+12}$ (Infosel)	0.98	π_t	0.01*
π_t	0.00*	π_t	0.00*	ε_{t+12}	0.93
π_{t+12}	0.32	ε_{t+12}	0.94	Monthly wholesale price inflation	0.14
ε_{t+12}	0.96	Monthly producers' price inflation	0.00*	Monthly output gap	0.36
Monthly wholesale price inflation	0.00*	Monthly output gap	0.00*	Monthly overnight interest rates	0.88
Monthly output gap	0.00*	Monthly interbank interest rates	0.63	Monthly exchange rate change	0.82
Monthly interbank interest rates	0.01*	Monthly TIIE28	0.49		
Monthly monetary policy rates	1.00	Monthly Cetes28	0.35		
Monthly exchange rate change	0.00*	Monthly exchange rate change (FIX)	0.00*		
Monthly external price inflation	−3.51				

* 95 percent confidence level.

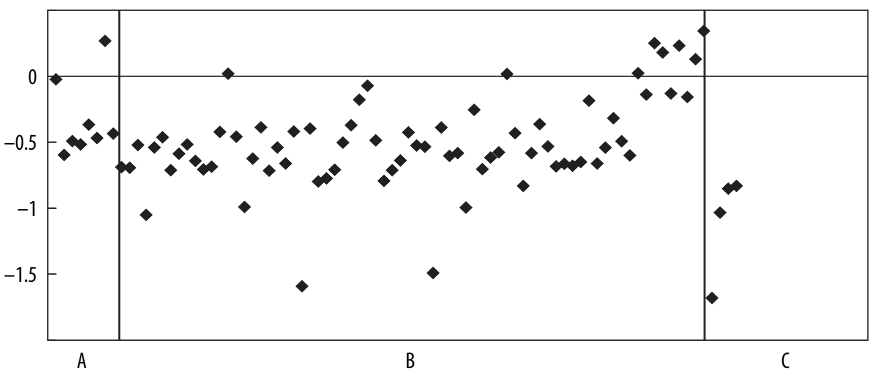
a. H_0: Unit root.

FIGURE 1. Mean Errors of Inflation Forecasts Surveyed by the Central Bank of Brazil[a]

A. One month ahead



B. Three months ahead

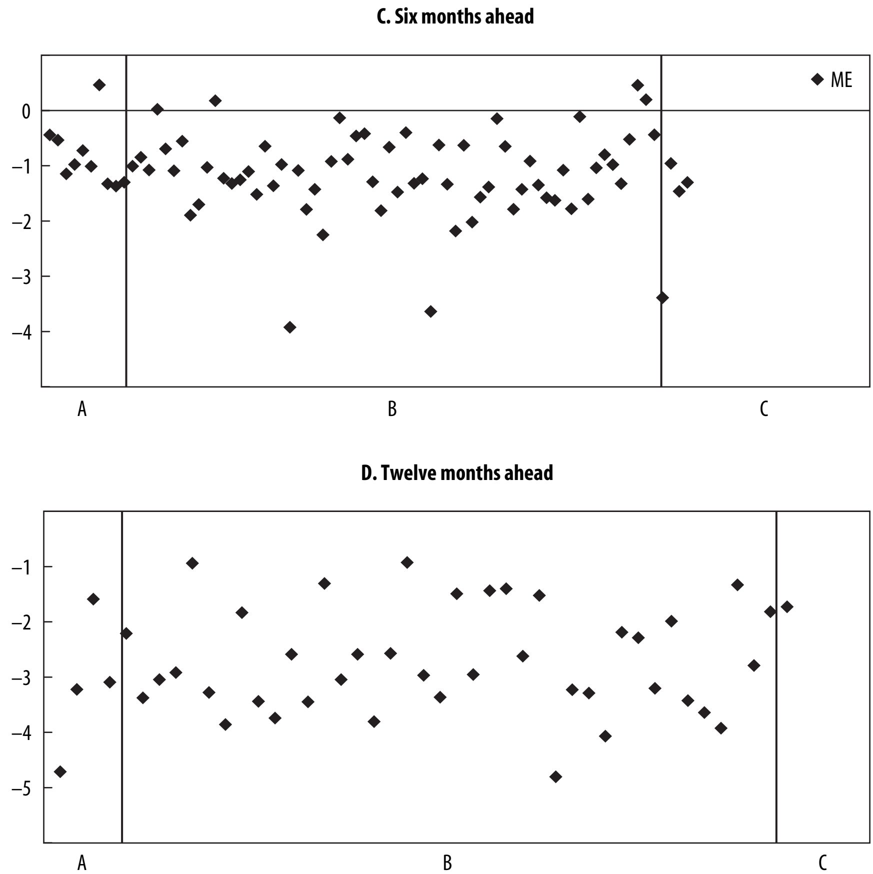


(continued)

In this paper, we analyze inflation forecasts that were valid on the last business day of each month. This implies that forecasters at that moment had already observed inflation realized in month $t - 1$, but they could not know inflation in month t. For our cross-section analysis, we removed participants with less than ten observations during the entire period sampled.

The mean forecast error calculated for each forecaster since the beginning of the IRO's survey suggests that forecasters have underpredicted inflation, on average (see figure 1). The mean bias in forecasts for inflation in the next month, the next three months, the next six months, and the next twelve months

FIGURE 1. Mean Errors of Inflation Forecasts Surveyed by the Central Bank of Brazil[a] *(Continued)*

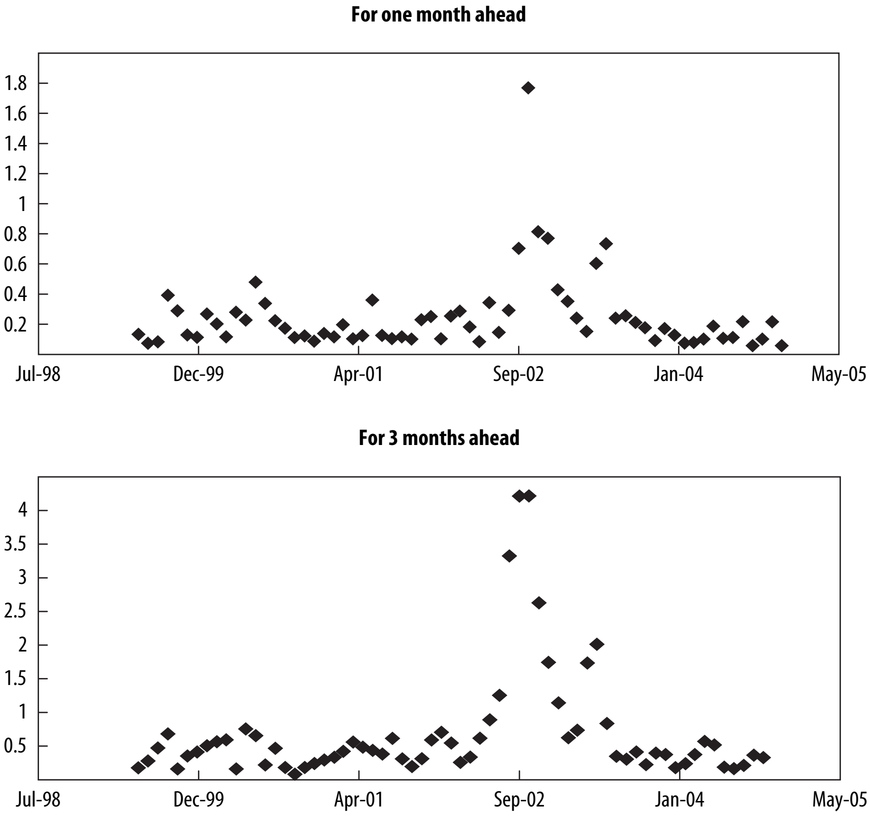


Source: Central Bank of Brazil, Investor Relations Office.

a. The sectors in the figure are as follows: A-consulting firms; B-financial institutions; and C-real sector firms. Each dot corresponds to the average forecast error of a single forecaster. Averages were calculated for the periods: one-month-ahead forecasts: June 1999 to December 2004; three-months-ahead forecasts: June 1999 to October 2004; six-months-ahead forecasts: September 1999 to July 2004; and twelve-months-ahead forecasts: June 1999 to January 2004. From June 1999 to October 2001, the latter were calculated as a linear interpolation of forecasts for December of each year.

was, respectively, –0.17 percentage point, –0.7 percentage point, –1.6 percentage points, and –3.8 percentage points (or 22 percent, 28 percent, 32 percent, and 43 percent of average inflation in the period). Visual inspection also suggests that a participant's affiliation does not influence the pattern of projections. In addition, mild evidence indicates that the magnitude of forecast errors is reducing over time (see figure 2).

FIGURE 2. Root Mean Squared Errors of Inflation Forecasts Surveyed by the Central Bank of Brazil[a]

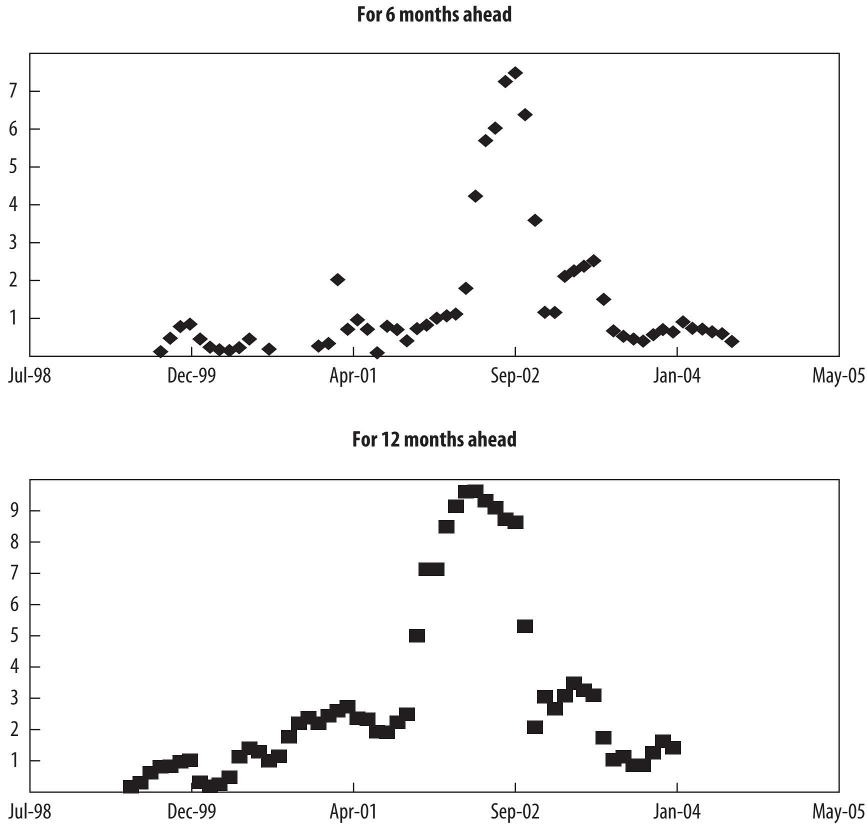


(continued)

The peaks observed in figure 2 resulted from a severe sequence of shocks that hit the Brazilian economy in 2002. Corporate accountability problems in the United States, the prospect of another Gulf war, weak global growth, and financial distress in emerging economies sharply reduced external flows to the country. Moreover, the approaching presidential election increased uncertainty regarding the future conduct of domestic macroeconomic policy. These external and internal factors together caused the exchange rate to depreciate. What was first taken as a temporary phenomenon proved to have stronger-than-expected effects on consumer price inflation.

Figure 3 suggests that inflation expectations in Brazil were well anchored until the third quarter of 2002. After September 2002, upcoming news on past

FIGURE 2. Root Mean Squared Errors of Inflation Forecasts Surveyed by the Central Bank of Brazil[a] *(Continued)*



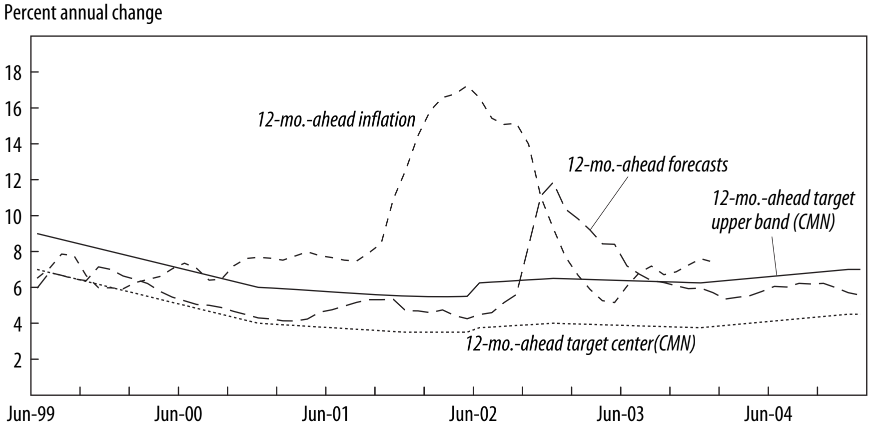
Source: Central Bank of Brazil, Investor Relations Office.

a. Each dot in the figure corresponds to the root of the average squared forecast error of all survey participants at a single point in time.

twelve-month accumulated inflation surprisingly pointed to increased inertial inflation, and market forecasts breached the upper target band for the first time since the implementation of the regime. It was a full year before inflation forecasts returned to within the target bands.

We carried out rationality tests on forecasts made for three-, six-, and twelve-month-ahead inflation, using both median forecasts surveyed by the Central Bank of Brazil and panel data from the same source (see tables 2 to 5). By applying two-stage least squares (2SLS) instrumented by lags of inflation expectations extracted from interest rate swaps, we find that median forecasts for

FIGURE 3. Twelve-Month-Ahead Inflation Forecasts, Targets, and Actual Inflation in Brazil[a]



Source: Central Bank of Brazil, Investor Relations Office.

a. Each point in time refers to inflation targeted, forecast, or realized twelve months later. Targets are set by the Brazilian Monetary Council (CMN) and refer only to December of each year; for the remaining months of the year, the figure shows approximate values of twelve-month-ahead targets, calculated as a linear interpolation of targets for annual inflation set for December of each year. Surveys on median expectations for inflation twelve months ahead are only available starting in November 2001; for earlier dates, the figure shows a linear interpolation of forecasts for annual inflation projected for December of each year.

twelve-month-ahead inflation (accumulated over months $t + 1$ to $t + 12$) are unbiased regardless of the assumption on the autocorrelation structure of the errors (see table 2).[13] Under the more stringent model specification (equation 2), median forecasts for all forecasting horizons analyzed here are unbiased with 90 percent confidence if we account for serial correlation in the errors.

Using a Newey-West covariance matrix, we find that over the entire period sampled, median forecasts for three-, six-, and twelve-month-ahead inflation have been efficient in the use of past information on consumer price inflation (IPCA) and interest rates (SELIC) (see table 3).[14] Shorter-term forecasts, however, do not fully account for the effects of wholesale price inflation and the exchange rate on consumer price inflation. As is standard in inflation-targeting regimes, monetary policy in Brazil does not attempt to offset the first-round

13. Lags of the output gap, consumer and producer price indices, the exchange rate, and interest rates proved to be poor instruments. All estimations in this work using maximum likelihood estimates yielded biased expectations, but this result is less robust than the others because maximum likelihood estimates perform relatively poorly in short samples.

14. The results using 2SLS refuted rationality even when we instrumented equation 1 with inflation expectations extracted from financial instruments.

TABLE 2. Tests of Unbiasedness of Median Inflation Forecasts Surveyed by the Investor Relations Office

Forecast horizon and econometric technique	*Model specification (eq. no.)*[a]	*Dependent variable*	*Regressors*	*Sampled period*	χ^2 *(p value)*[b]	*No. observations*
Forecast horizon: Twelve months ahead						
OLS	1	π_{t+12}	Constant, $E_t\pi_{t+12}$	Jun 1999 to Jan 2004	36.81 (0.00)	56
OLS	2	ε_{t+12}	Constant	Jun 1999 to Jan 2004	23.51 (0.00)	56
2SLS	1	π_{t+12}	Constant, $E_t\pi_{t+12}$	Jun 1999 to Jan 2004	0.22 (0.81)*	56
MLE MA(12)	1	π_{t+12}	Const., $E_t\pi_{t+12}$	Jun 1999 to Jan 2004	109.17 (0.00)	56
MLE MA(12)	2	ε_{t+12}	Constant	Jun 1999 to Jan 2004	124.77 (0.00)	56
2SLS with NW, MA(12)	1	π_{t+12}	Constant, $E_t\pi_{t+12}$	Jun 1999 to Jan 2004	0.08 (0.96)*	56
GLS with NW, MA(12)	2	ε_{t+12}	Constant	Jun 1999 to Jan 2004	3.92 (0.05)*	56
GLS with NW, MA(12)	2	ε_{t+12}	Constant	Nov 2001 to Jan 2004	2.09 (0.15)*	27
Forecast horizon: six months ahead						
OLS	2	ε_{t+6}	Constant	Sep 1999 to Jul 2004	7.18 (0.01)	54
GLS with NW, MA(6)	2	ε_{t+6}	Constant	Sep 1999 to Jul 2004	1.87 (0.17)*	54
Forecast horizon: three months ahead						
OLS	2	ε_{t+3}	Constant	Jun 1999 to Dec 2004	10.25 (0.00)	65
GLS with NW, MA(3)	2	ε_{t+3}	Constant	Jun 1999 to Dec 2004	4.17 (0.04)**	65

a. The instruments used in specification 1 were the inflation premium in 360-day interest rate swaps negotiated at Brazilian Mercantile and Futures Exchange (BM&F).

b. The symbols * and ** indicate that the tests cannot reject the unbiasedness assumption with 95 and 90 percent confidence, respectively. Joint hypothesis tests for OLS estimations are assumed to have an *F* distribution.

effects of supply shocks on inflation, which could increase the volatility of short-term inflation and thus heighten uncertainty as to its short-term behavior.

Longer-term forecasts have failed to extract all possible information from the output gap (see table 3).[15] Reading demand conditions in Brazil can be quite

15. The output gap in Brazil was estimated as the difference of the seasonally adjusted monthly output, calculated using a Cobb-Douglas equation whose inputs were installed capacity and employment rates and whose trend was extracted from a Hodrick-Prescott filter. The shares of labor and capital were estimated from yearly national accounts.

TABLE 3. Tests of Efficiency of Median Inflation Forecasts Surveyed by the Investor Relations Office

Forecast horizon and econometric technique	*Model specification (eq. no.)*	*Dependent variable*	*Regressors*	*Sampled period*	χ^2 *(p value)*[a]	*No. observations*
Forecast horizon: twelve months ahead						
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of wholesale price inflation	Jun 1999 to Jan 2004	9.00 (0.06)*	56
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of wholesale price inflation	Nov 2001 to Jan 2004	6.01 (0.20)*	27
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of output gap	Jun 1999 to Jan 2004	14.36 (0.01)	56
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of output gap	Nov 2001 to Jan 2004	18.53 (0.00)	27
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of consumer price inflation	Jun 1999 to Jan 2004	7.70 (0.10)*	56
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of consumer price inflation	Nov 2001 to Jan 2004	7.25 (0.12)*	27
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of the exchange rate variation	Jun 1999 to Jan 2004	9.40 (0.05)*	56
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of the exchange rate variation	Nov 2001 to Jan 2004	42.50 (0.00)	27
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of the overnight interest rate	Jun 1999 to Jan 2004	8.67 (0.07)*	56
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of the overnight interest rate	Nov 2001 to Jan 2004	32.41 (0.00)	27
Forecast horizon: six months ahead						
GLS with NW, MA(6)	2	ε_{t+6}	Constant, lags 1 to 3 of wholesale price inflation	Sep 1999 to Jul 2004	10.01 (0.04)**	54
GLS with NW, MA(6)	2	ε_{t+6}	Constant, lags 1 to 3 of output gap	Sep 1999 to Jul 2004	9.25 (0.06)*	54
GLS with NW, MA(6)	2	ε_{t+6}	Constant, lags 1 to 3 of consumer price inflation	Sep 1999 to Jul 2004	4.93 (0.30)*	54
GLS with NW, MA(6)	2	ε_{t+6}	Constant, lags 1 to 3 of the exchange rate variation	Sep 1999 to Jul 2004	28.96 (0.00)	54
GLS with NW, MA(6)	2	ε_{t+6}	Constant, lags 1 to 3 of the overnight interest rate	Sep 1999 to Jul 2004	4.28 (0.37)*	54
Forecast horizon: three months ahead						
GLS with NW, MA(3)	2	ε_{t+3}	Constant, lags 1 to 3 of wholesale price inflation	Jun 1999 to Oct 2004	16.16 (0.00)	65
GLS with NW, MA(3)	2	ε_{t+3}	Constant, lags 1 to 3 of output gap	Jun 1999 to Oct 2004	5.89 (0.21)*	65
GLS with NW, MA(3)	2	ε_{t+3}	Constant, lags 1 to 3 of consumer price inflation	Jun 1999 to Oct 2004	8.42 (0.08)*	65
GLS with NW, MA(3)	2	ε_{t+3}	Constant, lags 1 to 3 of the exchange rate variation	Jun 1999 to Oct 2004	48.00 (0.00)	65
GLS with NW, MA(3)	2	ε_{t+3}	Constant, lags 1 to 3 of the overnight interest rate	Jun 1999 to Oct 2004	8.67 (0.07)*	65

a. The symbols * and ** indicate that the tests cannot reject the unbiasedness assumption with 95 and 90 percent confidence, respectively. Joint hypothesis tests for OLS estimations are assumed to have an *F* distribution.

burdensome, and the output gap series that we have available for this study may contain revisions that were not known to forecasters by the time they made their predictions.[16] Keane and Runkle argue that the use of unknown revisions in the data should not be grounds for refuting rationality, as this particular information was not in the information set of forecasters.[17] We counterargue, however, that rational forecasters should be able to read other indicators of economic activity and realize the errors in measurement of the proxies they are considering.

Looking at individual inflation forecasts, 11 percent of the twelve-month-ahead forecasts are unbiased under model specification 2 regardless of the econometric technique employed.[18] This share increases to 41 percent if we restrict the sample to include only the period after November 2001. If we use a Newey-West covariance matrix to account for an autocorrelated structure of the errors, the share of unbiased forecasts increases to 71 percent for the entire history of the survey and to 97 percent for the period after November 2001.

None of the analyzed forecasters reported fully efficient forecasts for twelve-month-ahead inflation. Under the model specified in equation 2, and allowing for serial correlation in the errors, we find that forecasters have particular difficulty in using information on the exchange rate, the output gap, and the interest rate. The share of individual forecasters who efficiently used these variables to predict inflation was 24 percent, 24 percent, and 29 percent, respectively. The share of forecasters properly using information on past consumer and wholesale price inflation was much higher (76 percent and 78 percent, respectively).

The results of unbiasedness tests using panel data are even less favorable (see table 4). Forecasts for three-, six-, and twelve-month-ahead inflation surveyed since the beginning of the series are biased under pooled OLS and generalized least squares (GLS) with both robust Newey-West and Keane-Runkle covariance matrices. The panel of twelve-month-ahead inflation forecasts surveyed after November 2001 was the only one to pass the unbiasedness test using Keane and Runkle's method.[19] Nevertheless, these forecasts did not attain efficiency in the use of any of the variables investigated (see table 5).

16. Collecting and interpreting data of national relevance is complicated by the continental size of the country, and high frequency data are sometimes available only for São Paulo and Rio de Janeiro. Moreover, a very wide set of different indices is available for measuring economic activity. The choice of which index to track, if not all of them, can be highly arbitrary. Finally, published GDP figures have been systematically and significantly revised, adding uncertainty to future forecasts that use these variables.

17. Keane and Runkle (1990).

18. To test the rationality of individual forecasts, we removed participants that had reported fewer than twenty-five forecasts for the period from June 1999 to January 2005.

19. Keane and Runkle (1990).

TABLE 4. Tests of Unbiasedness of Inflation Forecasts Using Panel Data

Forecast horizon and econometric technique	*Model specification (eq. no.)*	*Dependent variable*	*Regressors*	*Sampled period*	*χ^2 (p value)*[a]	*No. observations*
Forecast horizon: twelve months ahead						
OLS	2	ε_{t+12}	Constant	Jun 1999 to Jan 2004	769.27 (0.00)	2045
OLS	2	ε_{t+12}	Constant	Nov 2001 to Jan 2004	364.64 (0.00)	1174
GLS with NW, MA(12)	2	ε_{t+12}	Constant	Jun 1999 to Jan 2004	158.78 (0.00)	2045
GLS with NW, MA(12)	2	ε_{t+12}	Constant	Nov 2001 to Jan 2004	74.40 (0.00)	1174
GLS with K&R, MA(12)	2	ε_{t+12}	Constant	Jun 1999 to Jan 2004	14.03 (0.00)	1836
GLS with K&R, MA(12)	2	ε_{t+12}	Constant	Nov 2001 to Jan 2004	1.40 (0.18)*	1836
Forecast horizon: six months ahead						
OLS	2	ε_{t+6}	Constant	Sep 1999 to Jul 2004	364.54 (0.00)	2317
GLS with NW, MA(6)	2	ε_{t+6}	Constant	Sep 1999 to Jul 2004	99.33 (0.00)	2317
GLS with K&R, MA(6)	2	ε_{t+6}	Constant	Oct 1999 to Jul 2004	7.91 (0.00)	2158
Forecast horizon: three months ahead						
OLS	2	ε_{t+3}	Constant	Jun 1999 to Jan 2005	420.22 (0.00)	2841
GLS with NW, MA(3)	2	ε_{t+3}	Constant	Jun 1999 to Jan 2005	177.41 (0.00)	2841
GLS with K&R, MA(3)	2	ε_{t+3}	Constant	Jun 1999 to Feb 2005	11.92 (0.00)	2664

a. The symbol * indicates that the tests cannot reject the unbiasedness assumption with 95 percent confidence. Joint hypothesis tests for OLS estimations are assumed to have an *F* distribution.

Keane and Runkle identify a number of reasons why their covariance matrix helps reduce the alleged bias toward refuting the rationality of U.S. forecasts.[20] In the Brazilian case, however, panel data regressions are biasing the results in the opposite direction. The expressive dispersion in the panel is a plausible candidate for explaining these results. Another possibility, considering that the survey is composed only of professional forecasters, is that people have not reached a consensus on the nature of Brazilian inflation dynamics, and that alone may have important implications for monetary policy.

20. Keane and Runkle (1990).

TABLE 5. Tests of Efficiency of Inflation Forecasts Using Panel Data

Forecast horizon and econometric technique	Model specification (eq. no.)	Dependent variable	Regressors	Sampled period	χ^2 (p value)	No. observations
Forecast horizon: twelve months ahead						
GLS with K&R, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of wholesale price inflation	Nov 2001 to Jan 2004	28.59 (0.00)	1836
GLS with K&R, MA(12)	4	ε_{t+12}	Constant, lags 2 to 3 of output gap	Nov 2001 to Jan 2004	2514.20 (0.00)	1836
GLS with K&R, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of consumer price inflation	Nov 2001 to Jan 2004	34.56 (0.00)	1836
GLS with K&R, MA(12)	4	ε_{t+12}	Constant, lags 2 to 3 of the exchange rate variation	Nov 2001 to Jan 2004	37.45 (0.00)	1836
GLS with K&R, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of the overnight interest rate	Nov 2001 to Jan 2004	32.17 (0.00)	1836

High uncertainty regarding the true state of the economy may cause expectations to behave in a way that is not suitable for price stabilization purposes. This seems to have been the case in Brazil in the last quarter of 2002 and the first two quarters of 2003. Evans and Honkapohja demonstrate that optimal "economic policies should be designed to avoid instabilities that can arise from expectational errors and the corrective behavior of economic agents in the face of such errors."[21] Levin, Wieland, and Williams show that when agents are highly uncertain about the model underlying inflation dynamics, inflation and output will exhibit higher variability than if the dynamics are well understood.[22] If central banks are concerned about this variability, they should try to reduce the uncertainty prevailing in the economy. An important step in this direction is to properly account for the fact that agents are indeed "learning" about the economy. Finally, Orphanides and Williams show that policies designed to be efficient under rational expectations can perform very poorly when knowledge is imperfect.[23] They argue that monetary policy should be stronger under learning than under rational expectations.

Rationality in Chile

The Central Bank of Chile has been announcing explicit inflation targets since 1991. For some years, inflation targets coexisted with exchange rate bands,

21. Evans and Honkapohja (2002, p. 6).
22. Levin, Wieland, and Williams (2003).
23. Orphanides and Williams (2002).

foreign capital control, and a monetary policy instrument defined over the premium on an inflation-indexed unit of account (*Unidad de Fomento,* or UF). In September 1999, however, the country adopted a floating exchange rate regime, after having abandoned foreign capital controls in 1998 to allow for more freedom and transparency in the conduct of monetary policy. In August 2001, the country started to use nominal overnight interest rates as a policy instrument, which shifted the focus away from real rates. Chile has achieved an impressive reduction in its fiscal fragilities: the central government's gross debt fell from 70.9 percent of GDP in 1989 to 38.9 percent in 2004, while its net debt dropped from 43 percent of GDP to 9.1 percent in the same period.

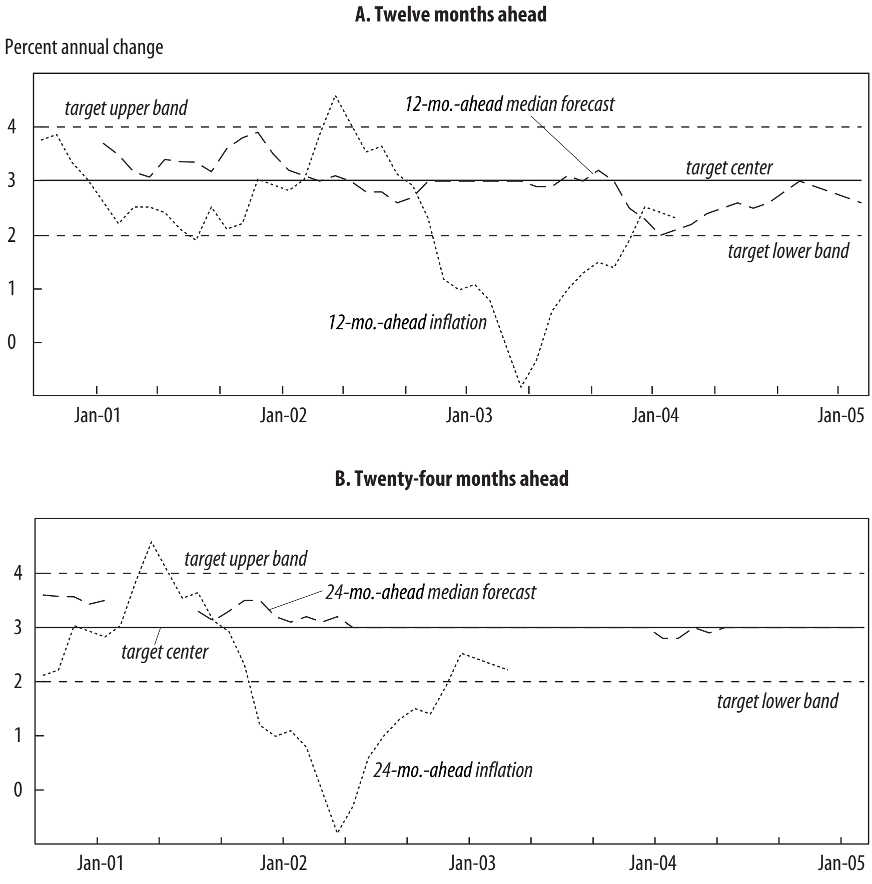
The central bank's inflation reports track inflation expectations surveyed by the University of Chile and Consensus Economics, as well as those extracted from financial instruments. In this study, we consider only the survey carried out by the University of Chile and reported on the central bank's website. The survey is conducted on a monthly basis with thirty to forty-five selected academics, consultants, and executives or advisors of financial institutions and corporations. Participants provide their forecasts to the Central Bank of Chile one day after the release of the consumer price index or the index of monthly activity (IMACEC). On the following day, the Central Bank reports on expectations for the next two months, eleven months, and twenty-four months, together with year-end inflation expectations. In this study, we report the rationality test results for twelve- and twenty-four-month-ahead inflation expectations.

Figure 4 shows that inflation expectations surveyed by the University of Chile have been very well anchored despite important inflationary surprises. The results are even more remarkable for longer forecast horizons. The sharp overestimation shown in the figure stems from a strong and unexpected appreciation of the Chilean peso at the end of 2003, caused by the depreciation of the U.S. dollar against other important currencies, improved conditions in emerging markets, and more favorable terms of trade. Lower-than-expected rises in unit labor costs in 2004 also contributed to inflation being below target bands.

After August 2000, median forecasts surveyed by the University of Chile overpredicted twelve- and twenty-four-month-ahead inflation by 0.9 percentage point, and 1.4 percentage points, respectively. Root mean square errors in Chile have been around 1.5 percentage points.

Median twelve-month-ahead inflation forecasts in Chile are unbiased if we employ a Newey-West covariance matrix that accounts for autoregressive forecast errors (see table 6). Using this technique to assess the degree of efficiency

FIGURE 4. Twelve- and Twenty-Four-Month-Ahead Inflation Forecasts, Targets, and Actual Inflation in Chile[a]



Source: Central Bank of Chile.

a. Each point in time refers to annual inflation targeted or forecast for the next eleven to twenty-three months, or realized eleven or twenty-three months later. Targets are set by the central bank in consultation with the finance minister for a twenty-four-month horizon. Median expectations for inflation twelve months ahead in the period January 2001 to August 2001 were approximated using forecasts for year-end inflation. Median expectations for inflation twenty-four months ahead in the period August 2000 to December 2000 and July 2001 to August 2001 were also approximated using year-end inflation. The gap between January 2001 and June 2001 is due to the lack of available public information.

TABLE 6. Tests of Unbiasedness of Median Inflation Forecasts Surveyed by the Universidad de Chile

Forecast horizon and econometric technique	*Model specification (eq. no.)*[a]	*Dependent variable*	*Regressors*	*Sampled period*	χ^2 *(p value)*[b]	*No. observations*
Forecast horizon: twelve months ahead						
OLS	1	π_{t+11}	Constant, $E_t\pi_{t+11}$	Jan 2001 to Feb 2004	8.53 (0.00)	31
OLS	2	ε_{t+11}	Constant	Jan 2001 to Feb 2004	13.56 (0.00)	31
MLE MA(11)	1	π_{t+11}	Constant, $E_t\pi_{t+11}$	Jan 2001 to Feb 2004	7.42 (0.02)	31
MLE MA(11)	2	ε_{t+11}	Constant	Jan 2001 to Feb 2004	54.58 (0.00)	31
2SLS with NW, MA(11)	1	π_{t+11}	Constant, $E_t\pi_{t+11}$	Oct 2001 to Feb 2004	2.78 (0.25)*	29
GLS with NW, MA(11)	2	ε_{t+11}	Constant	Jan 2001 to Feb 2004	3.13 (0.08)*	31
Forecast horizon: twenty-four months ahead						
OLS	1	π_{t+23}	Constant, $E_t\pi_{t+23}$	Jan 2001 to Mar 2003	26.89 (0.00)	20
OLS	2	ε_{t+23}	Constant	Jan 2001 to Mar 2003	56.76 (0.00)	20
2SLS	1	π_{t+23}	Constant, $E_t\pi_{t+23}$	Jan 2001 to Mar 2003	12.93 (0.00)	20
2SLS with NW, MA(23)	1	π_{t+23}	Constant, $E_t\pi_{t+23}$	Jan 2001 to Mar 2003	10.23 (0.01)	20
GLS with NW, MA(23)	2	ε_{t+23}	Constant	Jan 2001 to Mar 2003	57.52 (0.00)	20

a. For the twelve-month-ahead forecast horizon, the instruments used in specification 1 were the inflation premium in the yields of two-year Central Bank of Chile peso bonds (BCPs) over estimated two-year Central Bank of Chile UF bonds (BCUs). For the twenty-four-month-ahead forecast horizon, the instruments used in specification 1 were lags of the output gap; the ones with inflation expectations extracted from bonds or with wholesale price indexes performed worse.

b. The symbol * indicates that the tests cannot reject the unbiasedness assumption with 95 percent confidence. Joint hypothesis tests for OLS estimations are assumed to have an *F* distribution.

in median forecasts, we find that forecasters are making proper use of available information on the output gap, wholesale and consumer price inflation, the exchange rate, and interbank overnight rates (see table 7).[24]

Median inflation forecasts for twenty-four months ahead are biased under any econometric technique (see table 6). We are careful in analyzing these results, however, as the time series available is very short.

24. The output gap was calculated from the Central Bank of Chile's monthly index of economic activity (IMACEC) as the ratio of the seasonally adjusted indicator to its seasonally adjusted trend using a Hodrick-Prescott filter.

TABLE 7. Tests of Efficiency of Median Inflation Forecasts Surveyed by the Universidad de Chile

Forecast horizon and econometric technique	*Model specification (eq. no.)*	*Dependent variable*	*Regressors*	*Sampled period*	*χ^2 (p value)[a]*	*No. observations*
Forecast horizon: twelve months ahead						
GLS with NW, MA(11)	4	ε_{t+11}	Constant, lags 1 to 3 of output gap	Jan 2001 to Feb 2004	8.97 (0.06)*	31
GLS with NW, MA(11)	4	ε_{t+11}	Constant, lags 1 to 3 of wholesale price inflation	Jan 2001 to Feb 2004	6.21 (0.18)*	31
GLS with NW, MA(11)	4	ε_{t+11}	Constant, lags 0 to 1 of exchange rate variation	Jan 2001 to Feb 2004	5.27 (0.15)*	31
GLS with NW, MA(11)	4	ε_{t+11}	Constant, lags 1 to 3 of consumer price inflation	Jan 2001 to Feb 2004	5.27 (0.15)*	38
GLS with NW, MA(11)	4	ε_{t+11}	Constant, lags 1 to 3 of interbank interest rates	Jan 2001 to Feb 2004	6.72 (0.15)*	38

a. The symbol * indicates that the tests cannot reject the unbiasedness assumption with 95 percent confidence. Joint hypothesis tests for OLS estimations are assumed to have an *F* distribution.

Rationality in Mexico

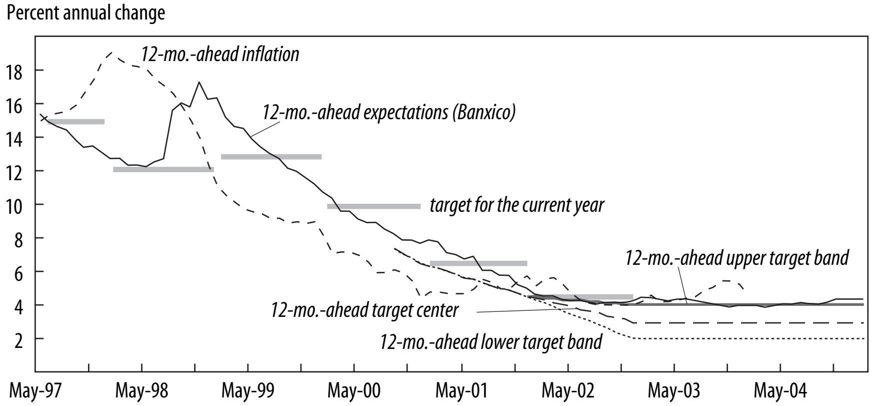
Mexico has been announcing explicit inflation targets since 1995, although the country only adopted a full-fledged inflation-targeting regime in January 2001, with the publication of inflation reports and concentrated efforts to derive a structural model for inflation.[25] A floating exchange rate regime had been in place since 1994. Unlike Brazil and Chile, Mexico uses influence over the monetary base as its operational instrument. In that regard, the International Monetary Fund (IMF) has explicitly suggested that Mexico adopt interest rate targets to replace the *corto* (the target for liquidity shortage in the bank reserves market), so as to reduce the volatility of market interest rates.[26] Mexico has also achieved impressive records of fiscal discipline: net public sector debt fell from 105 percent of GDP in 1987 to 20 percent of GDP in 2004.

In its inflation reports, the Bank of Mexico tracks inflation expectations surveyed internally and by Infosel (a local news agency), as well as those extracted from financial instruments. The Bank of Mexico's survey is carried out with about thirty private economic institutions, usually in the last week of the month.

Figure 5 shows that mean twelve-month-ahead inflation forecasts surveyed by both the central bank and Infosel have closely followed the upper target band since September 2001, when inflation target bands were announced. They have also significantly reduced their bias since July 2001. In the period

25. IMF (2001).
26. IMF (2001).

FIGURE 5. Twelve-Month-Ahead Inflation Forecasts, Targets, and Actual Inflation in Mexico[a]



Source: Bank of Mexico.

a. Each point in time refers to inflation (INPC) targeted, forecast, or realized twelve months later. Official inflation targets refer only to December of each year; for the remaining months of the year, the figure shows approximate values of twelve-month-ahead targets. Before November 2000, targets were announced for a maximum horizon of fourteen months ahead.

analyzed, inflation forecasts surveyed by the Bank of Mexico and Infosel had a mean average forecast error of only 0.4 percentage point and 0.6 percentage point, respectively. Root mean square forecast errors were around 2.6 percentage points over the entire sample, falling to around 1.0 percentage point after 2001. Although the sharp reduction in the forecast bias does not coincide exactly with the beginning of the formal adoption of the inflation-targeting regime, evidence indicates that the formalization of the regime helped improve the accuracy of forecasts.

Long-term inflation forecasts in both the Bank of Mexico's and Infosel's surveys are unbiased under any model specification or econometric technique (see table 8). For shorter-term horizons, the evidence of unbiasedness is strong for the subsample beginning in January 2001. For the entire period of the survey, six-month-ahead forecasts are unbiased only if we allow for serial correlation in the errors.

The central bank's and Infosel's expectations surveys are statistically equal, as shown in table 9, so here we report the tests for twelve-month-ahead inflation using the Bank of Mexico's survey and for shorter-horizons using Infosel's. When we allow for serial correlation in forecast errors, forecasts for any horizon are generally efficient in the use of available data on the output gap, the

TABLE 8. Tests of Unbiasedness of Mean Inflation Forecasts

Forecast horizon and econometric technique	Model specification (eq. no.)[a]	Dependent variable	Regressors	Sampled period	χ^2 (p value)[b]	No. observations
Forecast horizon: twelve months ahead[c]						
OLS	1	π_{t+12}	Constant, $E_t\pi_{t+12}$	May 1997 to Jan 2004	1.07 (0.35)*	81
OLS	1	π_{t+12}	Constant, $E_t\pi_{t+12}$	May 1997 to Dec 2000	0.77 (0.47)*	44
OLS	1	π_{t+12}	Constant, $E_t\pi_{t+12}$	Jan 2001 to Jan 2004	77.06 (0.00)	37
OLS	2	ε_{t+12}	Constant	May 1997 to Jan 2004	1.59 (0.21)*	81
OLS	2	ε_{t+12}	Constant	May 1997 to Dec 2000	1.22 (0.27)*	44
OLS	2	ε_{t+12}	Constant	Jan 2001 to Jan 2004	0.09 (0.76)*	44
MLE MA(12)	2	ε_{t+12}	Constant	May 1997 to Jan 2004	34.30 (0.00)	81
2SLS with NW, MA(12)	1	π_{t+12}	Constant, $E_t\pi_{t+12}$	May 1997 to Jan 2004	0.31 (0.86)*	81
GLS with NW, MA(12)	2	ε_{t+12}	Constant	May 1997 to Jan 2004	0.20 (0.65)*	81
GLS with NW, MA(12)	2	ε_{t+12}	Constant	May 1997 to Dec 2000	0.16 (0.69)*	44
GLS with NW, MA(12)	2	ε_{t+12}	Constant	Jan 2001 to Jan 2004	0.10 (0.75)*	37
Forecast horizon: six months ahead[d]						
OLS	2	ε_{t+6}	Constant	Dec 1998 to Jul 2004	8.24 (0.00)	68
OLS	2	ε_{t+6}	Constant	Jan 2001 to Oct 2004	1.44 (0.24)*	43
GLS with NW, MA(6)	2	ε_{t+6}	Constant	Dec 1998 to Jul 2004	2.28 (0.13)*	68
GLS with NW, MA(6)	2	ε_{t+6}	Constant	Jan 2001 to Oct 2004	0.41 (0.52)*	43
Forecast horizon: three months ahead[d]						
OLS	2	ε_{t+3}	Constant	Dec 1998 to Oct 2004	13.04 (0.00)	71
OLS	2	ε_{t+3}	Constant	Jan 2001 to Oct 2004	1.06 (0.31)*	46
GLS with NW, MA(3)	2	ε_{t+3}	Constant	Dec 1998 to Oct 2004	5.93 (0.02)	71
GLS with NW, MA(3)	2	ε_{t+3}	Constant	Jan 2001 to Oct 2004	0.51 (0.48)*	46

a. For the twelve-month-ahead forecast, the instruments used were lags of the producers' price index.

b. The symbol * indicates that the tests cannot reject the unbiasedness assumption with 95 percent confidence. Joint hypothesis tests for OLS estimations are assumed to have an *F* distribution.

c. Bank of Mexico survey.

d. Infosel survey.

TABLE 9. Statistical Difference between the Series from Infosel and Bank of Mexico[a]

Sample period	*Coefficient*	p *value*	*No. observations*	*Root mean squared error*
Nov 97 to Feb 05	−0.03591	0.125	88	0.21736
Nov 97 to Dec 00	−0.02789	0.518	38	0.26329
Jan 01 to Feb 05	−0.04200	0.100	50	0.17735

a. The dependent variable is the monthly difference between twelve-month-ahead expectations surveyed by Bank of Mexico and Infosel. The regressor is the constant.

exchange rate, and past consumer and wholesale price inflation (see table 10). Nevertheless, there is sharp evidence that Mexican forecasters have not been able to correctly assess the impact of interest rates (namely, the interbank, TIIE28, and CETES28 rates) on inflation. The emphasis given to monetary base control, rather than nominal interest rates, is the first suspect in this failure of rationality in Mexico, as it adds a layer of uncertainty about the transmission channel of monetary policy to inflation. Deriving conclusive arguments, however, would require a deeper investigation that is beyond the purpose of this paper.

The Formation of Inflation Expectations

In this section, we use one of Beeby, Hall, and Henry's methods of inferring the rule that forecasters use to project inflation.[27] We focus on inflation forecasts for twelve months ahead (and twenty-four months ahead in the case of Chile). Instead of assuming that we know the equation that governs the formation of inflation expectations, we make the much less restrictive assumption that forecasters could use any economic information that is publicly available to make their forecasts.

For each country, we first apply principal component analysis (PCA) to a very wide set of potential variables that forecasters could consider to form their expectations. We then select the series that are less correlated with the others (that is, that are more closely linked with each principal component) to include in the reduced set of regressors that will be used in stepwise regressions. After running stepwise regressions, we test for the presence of heteroskedasticity and autocorrelation in the regression errors as a means of checking the fit and robustness of the equations we obtain.[28] Tables 11 to 14

27. Beeby, Hall, and Henry (2001).
28. The results of the principal component analysis are available upon request.

TABLE 10. Tests of Efficiency of Mean Inflation Forecasts

Forecast horizon and econometric technique	Model specification (eq. no.)	Dependent variable	Regressors	Sampled period	χ^2 (p value)[a]	No. observations
Forecast horizon: twelve months ahead[b]						
OLS	3	π_{t+12}	Constant, $E_t\pi_{t+12}$, lags 1 to 3 of output gap	May 1997 to Jan 2004	1.58 (0.18)*	81
OLS	3	π_{t+12}	Constant, $E_t\pi_{t+12}$, lags 1 to 3 of consumer price inflation	May 1997 to Jan 2004	0.61 (0.69)*	81
OLS	3	π_{t+12}	Constant, $E_t\pi_{t+12}$, lags 1 to 3 of producer price inflation	May 1997 to Jan 2004	0.47 (0.80)*	81
OLS	3	π_{t+12}	Constant, $E_t\pi_{t+12}$, lags 1 to 3 of exchange rate variation	May 1997 to Jan 2004	1.92 (0.10)*	81
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of output gap	May 1997 to Jan 2004	1.79 (0.14)*	81
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of output gap	May 1997 to Dec 2000	3.06 (0.03)**	44
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of output gap	Jan 2001 to Jan 2004	8.37 (0.00)	37
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of consumer price inflation	May 1997 to Jan 2004	0.46 (0.77)*	81
OLS	4	ε_{t+12}	Constant, lags 0 to 2 of exchange rate variation	May 1997 to Jan 2004	2.21 (0.07)*	81
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of producer price inflation	May 1997 to Jan 2004	0.43 (0.79)*	81
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of interbank overnight rate	May 1997 to Jan 2004	214.80 (0.00)	60
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of TIIE28	May 1997 to Jan 2004	3.28 (0.01)	81
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of TIIE28	May 1997 to Dec 2000	1.90 (0.13)*	44
OLS	4	ε_{t+12}	Constant, lags 1 to 3 of TIIE28	Jan 2001 to Jan 2004	55.70 (0.00)	37
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of output gap	May 1997 to Dec 2000	3.12 (0.54)*	44
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of output gap	Jan 2001 to Jan 2004	8.70 (0.07)*	37
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of interbank overnight rate	May 1997 to Jan 2004	404.70 (0.00)	60
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of TIIE28	May 1997 to Jan 2004	4.86 (0.30)*	81
GLS with NW, MA(12)	4	ε_{t+12}	Constant, lags 1 to 3 of TIIE28	Jan 2001 to Jan 2004	103.10 (0.00)	37
Forecast horizon: six months ahead[c]						
OLS	4	ε_{t+6}	Constant, lags 1 to 3 of output gap	Jan 2001 to Jul 2004	1.77 (0.15)*	43
OLS	4	ε_{t+6}	Constant, lags 1 to 3 of consumer price inflation	Jan 2001 to Jul 2004	1.47 (0.23)*	43

(continued)

TABLE 10. Tests of Efficiency of Mean Inflation Forecasts *(Continued)*

Forecast horizon and econometric technique	*Model specification (eq. no.)*	*Dependent variable*	*Regressors*	*Sampled period*	χ^2 *(p value)*[a]	*No. observations*
OLS	4	ε_{t+6}	Constant, lags 1 to 3 of producer price inflation	Jan 2001 to Jul 2004	0.41 (0.80)*	43
OLS	4	ε_{t+6}	Constant, lags 1 to 3 of exchange rate variation	Jan 2001 to Jul 2004	0.64 (0.64)*	43
OLS	4	ε_{t+6}	Constant, lags 1 to 3 of interbank overnight rate	Jan 2001 to Jul 2004	10.75 (0.01)	43
OLS	4	ε_{t+6}	Constant, lags 1 to 3 of TIIE28	Jan 2001 to Jul 2004	11.47 (0.00)	43
OLS	4	ε_{t+6}	Constant, lags 1 to 3 of CETES28	Jan 2001 to Jul 2004	9.30 (0.00)	43
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of output gap	Dec 1998 to Jul 2004	6.79 (0.15)*	68
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of consumer price inflation	Dec 1998 to Jul 2004	4.59 (0.33)*	68
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of producer price inflation	Dec 1998 to Jul 2004	6.06 (0.19)*	68
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of exchange rate variation	Dec 1998 to Jul 2004	4.41 (0.35)*	68
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of interbank overnight rate	Dec 1998 to Jul 2004	14.03 (0.01)	68
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of TIIE28	Dec 1998 to Jul 2004	8.96 (0.06)*	68
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of interbank overnight rate	Jan 2001 to Jul 2004	23.69 (0.00)	43
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of TIIE28	Jan 2001 to Jul 2004	25.80 (0.00)	43
GLS with NW, MA(6)	4	ε_{t+6}	Constant, lags 1 to 3 of CETES28	Jan 2001 to Jul 2004	20.15 (0.00)	43
Forecast horizon: three months ahead[c]						
OLS	4	ε_{t+3}	Constant, lags 1 to 3 of output gap	Jan 2001 to Oct 2004	1.79 (0.15)*	46
OLS	4	ε_{t+3}	Constant, lags 1 to 3 of consumer price inflation	Jan 2001 to Oct 2004	1.00 (0.42)*	46
OLS	4	ε_{t+3}	Constant, lags 1 to 3 of exchange rate variation	Jan 2001 to Oct 2004	1.18 (0.33)*	46
OLS	4	ε_{t+3}	Constant, lags 1 to 3 of producer price inflation	Jan 2001 to Oct 2004	0.77 (0.55)*	46
OLS	4	ε_{t+3}	Constant, lags 1 to 3 of interbank overnight rate	Jan 2001 to Oct 2004	5.98 (0.00)	46
OLS	4	ε_{t+3}	Constant, lags 1 to 3 of TIIE28	Jan 2001 to Oct 2004	6.10 (0.00)	46
OLS	4	ε_{t+3}	Constant, lags 1 to 3 of CETES28	Jan 2001 to Oct 2004	5.57 (0.00)	46

(continued)

TABLE 10. Tests of Efficiency of Mean Inflation Forecasts *(Continued)*

Forecast horizon and econometric technique	*Model specification (eq. no.)*	*Dependent variable*	*Regressors*	*Sampled period*	χ^2 *(p value)*[a]	*No. observations*
GLS with NW, MA(3)	4	ε_{t+3}	Constant, lags 1 to 3 of interbank overnight rate	Jan 2001 to Oct 2004	15.63 (0.00)	46
GLS with NW, MA(3)	4	ε_{t+3}	Constant, lags 1 to 3 of TIIE28	Jan 2001 to Oct 2004	16.26 (0.00)	46
GLS with NW, MA(3)	4	ε_{t+3}	Constant, lags 1 to 3 of CETES28	Jan 2001 to Oct 2004	14.87 (0.00)	46

a. The symbols * and ** indicate that the tests cannot reject the unbiasedness assumption with 95 and 90 percent confidence, respectively. Joint hypothesis tests for OLS estimations are assumed to have an *F* distribution

b. Bank of Mexico survey.

c. Infosel survey.

show the results of the stepwise regressions that are free of heteroskedasticity and autocorrelation.

In Brazil, Chile, and Mexico, inflation targets are not exactly set for a twelve-month-ahead horizon. The targets used in the stepwise regressions are thus an approximation of the target for the same period in which inflation expectations are formed. In the Brazilian case, this procedure is highly justifiable because, since 2001, the central bank has been attempting to shift the focus of market analysts' and society's attention to a twelve-month-ahead horizon rather than the end of the calendar year. Inflation targets are set two years in advance, and they refer to inflation at the end of each year, so forecasters can easily approximate the target trajectory for twelve months ahead. In fact, the central bank has also followed this procedure in its inflation reports.

In the Chilean case, inflation targets are set for a long-term horizon of about two years. In the period analyzed in this study, they were invariant at 3 percent. It is reasonable to assume that the official target works as a forward-looking signal to where inflation is heading in shorter horizons. Nevertheless, long-term targets in Chile should not be expected to function as a perfect anchor for short-term inflation expectations. If shocks change the viable path of inflation, monetary policy will only be able to counterbalance the second-round effects after one year, as the monetary policy lag in Chile is about one to two years. Given that a significant shock to inflation occurred during the period analyzed in this study, we would expect to find that economic variables other than the proxies for inflation targets are affecting the formation of inflation expectations. Indeed, the stepwise regressions yield this result (table 11). Past levels

TABLE 11. The Formation Rule of Inflation Forecasts Surveyed by the Universidad de Chile[a]

	Coefficient	p *value*	*[95% confidence interval]*	
Forecast horizon: twelve months ahead				
$E_t\pi_{t+11}$				
Constant	0.42	0.02	0.09	0.75
$E_t\pi_{t+11}(-1)$	0.85	0.00	0.73	0.97
Output gap (−1)	0.11	0.02	0.02	0.20
Exchange rate change (−1)	0.03	0.00	0.01	0.04
Summary statistic				
No. observations	40			
$F(3, 36)$	77.53			
Probability $> F$	0.00			
R squared	0.866			
Adjusted R squared	0.8548			
Root mean squared error	0.1379			
Source	*SS*	*df*	*MS*	
Model	4.423157	3	1.474386	
Residual	0.684593	36	0.019016	
Total	5.107750	39	0.130968	
Breusch–Godfrey LM test for autocorrelation[b]				
Lags (p)	*F*	*df*	*Prob* $> F$	
1	0.641	(1, 35)	0.4289	
LM test for autoregressive conditional heteroskedasticity (ARCH)[c]				
Lags (p)	χ^2	*df*	*Prob* $> \chi^2$	
1	3.409	1	0.0649	
Forecast horizon: twenty-four months ahead				
$E_t\pi_{t+23}$				
Constant	2.87	0.00	2.81	2.92
Interbank interest rate (−3)	−0.20	0.00	−0.28	−0.12
Interbank interest rate (−2)	0.18	0.02	0.03	0.33
Interbank interest rate (−1)	0.07	0.12	−0.02	0.17
Consumer price inflation (−2)	0.05	0.04	0.00	0.10
Output gap (−1)	0.03	0.09	−0.01	0.07
Exchange rate change (−1)	0.01	0.00	0.01	0.02
Foreign inflation (−3)	−0.01	0.13	−0.03	0.00
Summary statistic				
No. observations	41			
$F(7, 33)$	29.38			
Probability $> F$	0.00			
R squared	0.8617			
Adjusted R squared	0.8324			
Root mean squared error	0.05372			

(continued)

TABLE 11. The Formation Rule of Inflation Forecasts Surveyed by the Universidad de Chile[a] *(Continued)*

	Coefficient	p *value*	*[95% confidence interval]*
Source	*SS*	*df*	*MS*
Model	0.593537	7	0.084791
Residual	0.095243	33	0.002886
Total	0.688781	40	0.01722
Breusch–Godfrey LM test for autocorrelation[b]			
Lags (p)	*F*	*df*	*Prob > F*
1	0.014	(1, 32)	0.9062
LM test for autoregressive conditional heteroskedasticity (ARCH)[c]			
Lags (p)	χ^2	*df*	*Prob* > χ^2
1	0.269	1	0.6039

a. The sample period is from January 2001 to February 2005. The set of regressors considered in the stepwise regression are as follows: $E_t\pi_{t+23}$ (−1); lags 1 to 3 of consumer price inflation; lags 2 to 3 of the seasonally adjusted change in M1; lags 1 to 3 of the change in copper prices; lags 1 to 3 of the output gap; lags 1 to 3 of the change in the trade balance; lags 1 to 3 of the change in the exchange rate; lags 1 to 3 of the change in foreign inflation; lags 1 to 3 of monetary policy interest rates; lags 1 to 3 of wholesale price inflation; and a constant.

b. The null hypothesis is no serial correlation.

c. The null hypothesis is no ARCH effects, versus the alternative hypotheses (H_1) of ARCH (*p*) disturbance.

of inflation forecasts play a very important role in the formation of inflation expectations. Approximated inflation targets are significant, but they do not play as important a role.[29]

For a longer forecast horizon (twenty-four months ahead), however, we found that the credibility of inflation targets is very high in Chile. Past forecast errors do not play any role in determining inflation expectations, and, to a much lower extent, past variables also help explain the formation of long-term inflation expectations. This is likely due to the 8.3 percent share of regulated (backward-looking) prices in the economy. The inflation report of September 2004 also identifies the consumer price index (CPI) item "services" as being backward looking. The share of services in the CPI basket is around 30 percent.

Mexico displays evidence of an adaptive behavior in the formation of inflation expectations (see table 12). Stepwise regressions carried out on the series after January 2001 suggest that past supply and demand conditions, alongside forecast errors, have been important in the formation of inflation forecasts. The

29. We attempted to include in the set of regressors a variable for short-horizon forecast errors known to forecasters. Although significant, these forecast errors were not sufficient to account for a strong autocorrelation structure of the errors.

TABLE 12. The Formation Rule of Inflation Forecasts Surveyed by the Bank of Mexico after January 2001[a]

	Coefficient	*Standard error*	t *statistic*	p *value*	*[95% confidence*	*interval]*
Forecast horizon: twelve months ahead						
$E_t\pi_{t+12}$						
Constant	−1.23	0.35	−3.56	0.00	−1.93	−0.53
Upper inflation target band for twelve months ahead	1.14	0.12	9.84	0.00	0.91	1.38
Inflation of administered prices (−3)	−0.10	0.03	−3.79	0.00	−0.15	−0.04
Output gap (−1)	−0.09	0.04	−2.09	0.04	−0.17	0.00
Forecast error for six-month-ahead inflation (−7)	−0.08	0.03	−2.95	0.01	−0.14	−0.03
CETES28 interest rate (−2)	0.07	0.03	2.02	0.05	0.00	0.14
CETES28 interest rate (−3)	0.04	0.03	1.73	0.09	−0.01	0.10
Exchange rate change (FIX) (−1)	0.04	0.01	3.06	0.00	0.01	0.06
Exchange rate change (FIX) (−3)	−0.02	0.01	−1.58	0.12	−0.04	0.01
M1 (−2)	0.02	0.01	3.27	0.00	0.01	0.03
Trade balance (−1)	0.00	0.00	−2.72	0.01	0.00	0.00
Summary statistic						
No. observations	49					
F (10, 38)	293.58					
Probability > *F*	0					
R squared	0.9872					
Adjusted R squared	0.9839					
Root mean squared error	0.1389					
Source	*SS*	*df*	*MS*			
Model	56.63751	10	5.663751			
Residual	0.733091	38	0.019292			
Total	57.3706	48	1.195221			
Breusch–Godfrey LM test for autocorrelation[b]						
Lags (p)	*F*	*df*	*Prob > F*			
1	4.217	(1, 37)	0.0471			
LM test for autoregressive conditional heteroskedasticity (ARCH)[c]						
Lags (p)	χ^2	*df*	*Prob* > χ^2			
1	0.015	1	0.9038			

a. The sample period is from January 2001 to February 2005. The set of regressors considered in the stepwise regression are as follows: lag 7 of the forecast error for six-month-ahead inflation; the upper target band for twelve-month-ahead inflation; lags 1 to 3 of consumer price inflation; lags 2 to 3 of the seasonally adjusted change in M1; lags 1 to 3 of administered price inflation; lags 1 to 3 of the output gap; lag 1 of the change in the trade balance; lags 1 to 3 of the change in the exchange rate; lags 1 to 3 of the change in foreign inflation; lags 1 to 3 of CETES28 interest rates; lag 3 of Brent oil price inflation; a constant; and lags 1 to 3 of producer price inflation.

b. The null hypothesis is no serial correlation.

c. The null hypothesis is no ARCH effects, versus the alternative hypotheses (H_1) of ARCH (p) disturbance.

significant presence of demand variables suggests that agents look at information other than the proxy of the inflation target to estimate future core inflation.

Figure 5 suggests that inflation forecasts have been very well anchored by inflation targets since January 2002. Indeed, stepwise regressions on this subsample indicate that the constant is significantly close to the target center, and supply and demand variables other than interest rates have lost much of their power to affect the formation of inflation forecasts (see table 13). The strong effect of interest rates on inflation forecasts, however, suggests that there is still room for improvement in the credibility of inflation targets.

Expectations in Brazil showed a unique behavior among the countries selected for this study. For the subperiod before the shocks that hit the economy in 2002, the estimated coefficients for target bands were significant and very close to one, which implies high credibility (see table 14). However, past supply, demand, and inertial conditions have also influenced inflation expectations. The (positive) signs obtained for lagged interest rates suggest a nonlinear relation between twelve-month-ahead inflation and lagged interest rates. The constant is only eliminated from the regressions if we allow for the change in the interest rates (SELIC), rather than their level, to explain the level of inflation expectations. In this nonstandard setup, inflation targets gain more importance in explaining expectations.

A very important adaptive behavior arises in the sample after November 2002, which excludes a possible structural break in the series of inflation forecasts. In this subperiod, there is no evidence that inflation targets played any role in the formation of inflation forecasts. In fact, two concurrent specifications suggest that past supply conditions, coupled with either the past level of inflation expectations or demand conditions, determined inflation expectations. Either scenario has important implications for credibility of inflation targets in Brazil.[30]

In October 2002, the Central Bank of Brazil resumed the stable path for interest rate targets and increased the SELIC target from 18 percent a year to 21 percent a year. Further rounds of interest rate increases occurred through February 2003, when the central bank increased the SELIC target to 26.5 percent a year. The target rate remained at this level until June 2003, when inflation expectations were finally in line with target bands. As a result of restrictive monetary policy, real output growth was 1.92 percent in 2002 and 0.54 percent in 2003. The international scenario that put pressure on the Brazilian exchange

30. Using unofficial targets announced by the central bank yielded similar results.

TABLE 13. The Formation Rule of Inflation Forecasts Surveyed by the Bank of Mexico after December 2002[a]

	Coefficient	Standard error	t statistic	p value	[95% confidence	interval]
Forecast horizon: twelve months ahead						
$E_t\pi_{t+12}$						
Constant	3.09	0.07	42.08	0.00	2.93	3.24
CETES28 interest rate (−3)	0.15	0.01	14.03	0.00	0.13	0.17
Output gap (−1)	0.09	0.02	4.23	0.00	0.05	0.14
Forecast error for 6–month ahead inflation (−7)	0.04	0.02	1.63	0.12	−0.01	0.08
Inflation of administered prices (−1)	0.03	0.01	2.84	0.01	0.01	0.06
Exchange rate change (Fix) (−1)	0.02	0.01	4.20	0.00	0.01	0.04
Exchange rate change (Fix) (−2)	0.02	0.01	3.14	0.01	0.01	0.03
Exchange rate change (Fix) (−3)	0.01	0.01	1.90	0.08	0.00	0.02
Inflation of external prices (−3)	0.00	0.00	−2.21	0.04	0.00	0.00
Inflation of external prices (−1)	0.00	0.00	3.08	0.01	0.00	0.00
Summary statistic						
No. observations	26					
F(9, 16)	30.51					
Probability > *F*	0.00					
R squared	0.94					
Adjusted *R* squared	0.91					
Root mean squared error	0.05					
Source	*SS*	*df*	*MS*			
Model	0.789134	9	0.087682			
Residual	0.045978	16	0.002874			
Total	0.835112	25	0.033404			
Breusch–Godfrey LM test for autocorrelation[b]						
Lags (p)	*F*	*df*	*Prob > F*			
1	0.146	(1, 15)	0.7075			
LM test for autoregressive conditional heteroskedasticity (ARCH)[c]						
Lags (p)	χ^2	*df*	*Prob >* χ^2			
1	1.852	1	0.1736			

a. The sample period is from December 2002 to February 2005. The set of regressors considered in the stepwise regression are as follows: lag 7 of forecast error for six-month-ahead inflation; a constant; lags 1 to 3 of consumer price inflation; lags 2 to 3 of the seasonally adjusted change in M1; lags 1 to 3 of administered price inflation; lags 1 to 3 of the output gap; lag 1 of the change in the trade balance; lags 1 to 3 of the change in the exchange rate; lags 1 to 3 of the change in foreign inflation; lags 1 to 3 of CETES28 interest rates; lag 3 of Brent oil price inflation; and lags 1 to 3 of producer price inflation.

b. The null hypothesis is no serial correlation.

c. The null hypothesis is no ARCH effects, versus the alternative hypotheses (H_1) of ARCH (*p*) disturbance.

TABLE 14. The Formation Rule of Inflation Forecasts Surveyed by the Brazilian Investor Relations Office

	Coefficient	*Standard error*	t *statistic*	p *value*	*[95% confidence*	*interval]*
Forecast horizon: twelve months ahead[a]						
$E_t\pi_{t+12}$						
Constant	−1.71	0.42	−4.07	0.00	−2.58	−0.84
Center of Monetary Council's target (proxy for twelve months ahead)	0.86	0.05	16.98	0.00	0.75	0.96
Interest rate (SELIC) (−2)	0.75	0.07	10.23	0.00	0.60	0.91
Interest rate (SELIC) (−3)	−0.59	0.07	−8.00	0.00	−0.74	−0.44
Forecast error for three−month-ahead inflation (−4)	−0.25	0.06	−4.07	0.00	−0.37	−0.12
Wholesale price inflation (−1)	0.10	0.07	1.53	0.14	−0.03	0.24
U.S. producer price inflation (−1)	−0.10	0.03	−2.84	0.01	−0.17	−0.03
M1 (−1)	−0.01	0.01	−2.24	0.03	−0.03	0.00
Summary statistic						
No. observations	33					
$F(7, 25)$	98.38					
Probability > F	0.00					
R squared	0.97					
Adjusted R squared	0.96					
Root mean squared error	0.18					
Source	*SS*	*df*	*MS*			
Model	22.04376	7	3.149108			
Residual	0.80028	25	0.032011			
Total	22.84404	32	0.713876			
Breusch–Godfrey LM test for autocorrelation[b]						
Lags (p)	*F*	*df*	*Prob > F*			
1	0.116	(1, 24)	0.7367			
LM test for autoregressive conditional heteroskedasticity (ARCH)[c]						
Lags (p)	χ^2	*df*	*Prob >* χ^2			
1	1.505	1	0.2199			
Forecast horizon: twelve months ahead[d]						
Alternative 1: Forecast errors in the set of possible regressors						
$E_t\pi_{t+12}$						
Constant	1.81	0.54	3.32	0.00	0.68	2.94
U.S. CPI (−1)	−0.93	0.31	−2.97	0.01	−1.58	−0.28
SELIC interest rate (−2)	−0.59	0.11	−5.14	0.00	−0.83	−0.35
SELIC interest rate (−1)	0.82	0.11	7.41	0.00	0.59	1.04
Wholesale price inflation (−1)	0.77	0.09	8.83	0.00	0.59	0.96
Exchange rate change (−1)	0.02	0.01	1.64	0.12	−0.01	0.05

(continued)

TABLE 14. The Formation Rule of Inflation Forecasts Surveyed by the Brazilian Investor Relations Office *(Continued)*

	Coefficient	*Standard error*	t *statistic*	p *value*	*[95% confidence*	*interval]*
Summary statistic						
No. observations	27					
$F(5, 21)$	76.24					
Probability > F	0.00					
R squared	0.95					
Adjusted R squared	0.94					
Root mean squared error	0.48					
Source	*SS*	*df*	*MS*			
Model	86.20964	5	17.24193			
Residual	4.74947	21	0.226165			
Total	90.95911	26	3.498427			
Breusch–Godfrey LM test for autocorrelation[b]						
Lags (p)	*F*	*df*	*Prob > F*			
1	0.305	(1, 20)	0.5868			
LM test for autoregressive conditional heteroskedasticity (ARCH)[c]						
Lags (p)	χ^2	*df*	*Prob* $> \chi^2$			
1	0.916	1	0.3385			
Forecast horizon: twelve months ahead[d]						
Alternative 2: Past level of inflation forecasts in the set of possible regressors						
$E_t\pi_{t+12}$						
Consumer price inflation (–1)	–1.35	0.34	–3.99	0.00	–2.05	–0.64
Consumer price inflation (–2)	–0.51	0.20	–2.51	0.02	–0.93	–0.08
Consumer price inflation (–3)	0.68	0.18	3.89	0.00	0.31	1.05
Wholesale price inflation (–1)	0.99	0.11	8.84	0.00	0.76	1.22
$E_t\pi_{t+12}$ (–1)	0.94	0.09	10.38	0.00	0.75	1.13
U.S. PPI (–1)	–0.24	0.08	–3.10	0.01	–0.41	–0.08
Constant	0.24	0.47	0.51	0.61	–0.74	1.22
Exchange rate change (–1)	0.02	0.01	1.87	0.08	0.00	0.04
Summary statistic						
No. observations	27					
$F(7, 19)$	92.75					
Probability > F	0.00					
R squared	0.97					
Adjusted R squared	0.96					
Root mean squared error	0.37					
Source	*SS*	*df*	*MS*			
Model	88.37284	7	12.62469			
Residual	2.586278	19	0.13612			
Total	90.95911	26	3.498427			

(continued)

TABLE 14. The Formation Rule of Inflation Forecasts Surveyed by the Brazilian Investor Relations Office *(Continued)*

	Coefficient	*Standard error*	t *statistic*	p *value*	*[95% confidence interval]*
Breusch–Godfrey LM test for autocorrelation[b]					
Lags (p)	*F*	*df*	*Prob > F*		
1	1.194	(1, 18)	0.289		
LM test for autoregressive conditional heteroskedasticity (ARCH)[c]					
Lags (p)	χ^2	*df*	*Prob >* χ^2		
1	0.007	1	0.9347		

a. The sample period is from June 1999 to June 2002. The set of regressors considered in the stepwise regression are as follows: lag 4 of the forecast error for three-month-ahead inflation; the center of the target band for twelve-month-ahead inflation; a constant; lags 1 to 3 of consumer price inflation; lag 1 of the seasonally adjusted change in M1; lags 1 to 3 of SELIC interest rates; lags 1 to 3 of the output gap; lag 1 of net public sector debt over GDP; lags 1 to 3 of wholesale price inflation; lag 1 of the change in the exchange rate; lags 1 to 3 of U.S. CPI and PPI inflation; and lags 1 to 3 of wholesale price inflation.

b. The null hypothesis is no serial correlation.

c. The null hypothesis is no ARCH effects, versus the alternative hypotheses (H_1) of ARCH (p) disturbance.

d. The sample period is from October 2002 to January 2005. The set of regressors considered in the stepwise regression are as follows: $E_t\pi_{t+12}(-1)$; the center of target band for twelve-month-ahead inflation; a constant; lags 1 to 3 of consumer price inflation; lag 1 of the seasonally adjusted change in M1; lags 1 to 3 of SELIC interest rates; lags 1 to 3 of the output gap; lag 1 of net public sector debt over GDP; lags 1 to 3 of wholesale price inflation; lag 1 of the change in the exchange rate; lags 1 to 3 of U.S. CPI and PPI inflation; and lags 1 to 3 of wholesale price inflation.

rate in 2002 was also common to Chile and Mexico, so the strong misalignment of inflation expectations was caused by domestic sources.[31]

In contrast with Chile and Mexico, the Central Bank of Brazil has not been granted legal autonomy, and presidential elections thus generate uncertainty regarding the future conduct of monetary policy. Theoretical models of information economics show that this type of uncertainty causes inflation expectations to be higher than what would be desirable to a central banker who gives a high priority to stabilizing inflation at low levels.[32]

In a companion paper, we present a monetary policy model featuring uncertainty about the type of central banker in a framework in which the inflation targets are set by a third party, as is the case in Brazil.[33] We show that impor-

31. Other factors could also be explaining the strong misalignment of inflation expectations in Brazil. Despite several years of good fiscal records, public sector debt is still significantly higher than in Chile or Mexico. The Brazilian government's gross debt rose from 42 percent of GDP in 1998 to 72 percent of GDP in 2005 percent, while the net public sector debt increased from 42 percent of GDP in 1991 to 50 percent of GDP in 2005 percent. This is also evidence that the credibility of monetary policy in Brazil is affected by factors that are extraneous to monetary policy itself. Central Bank independence would help reduce this contagion.

32. See, for example, Vickers (1986); Cukierman and Liviatan (1991).

33. Bugarin and Carvalho (2005).

tant implications arise in the absence of a mechanism that ensures convergence of beliefs regarding the future behavior of the central banker. The theoretical model makes explicit the role of social stability for the type of equilibrium that results. In a stable society, the model predicts a low recession cost when strong central bankers want to signal their type. In unstable countries, which exhibit a high turnover of very distinct political parties in power, there will be greater heterogeneity among the types of central bankers. This heterogeneity will induce an equilibrium in which strong central bankers need to impose high recession costs to society in order to signal their type.

Within a fragile institutional framework, the prospect of a change in political parties may enact an undesirable update of society's priors on what type the next central banker will be. As the model shows, if society attributes a high probability to the next central banker being weak, inflation expectations will increase. Should the real central banker then turn out to be strong, the economy will experience important recession costs. Central bank autonomy per se does not reduce the heterogeneity among the types of central bankers. But if the institutional design is appropriate, it may reduce uncertainty about the choice of monetary policy and thus the recession costs imposed on a strong central banker.

Another important implication of the model is that forecasters recognize that the central bank will typically not reach the center of the inflation target, even if the central banker attributes a relatively high importance to the variance of inflation around the targets. But if the center of inflation targets is usually not attained, then why should the government set an inflation target? The model shows that the target directly affects the central banker's optimal choice of inflation, and, as such, it signals the future path of inflation to society.

If the authority that sets the target wishes, for instance, to reduce equilibrium inflation, it shall act strategically by setting a low target. Since a political cost is usually associated with not achieving the targets, the authority shall aim to reduce this cost by defining an inflation target band around the center. Moreover, if the political cost associated with the failure to achieve the targets is sufficiently high or if the credibility of the central bank is low ex ante, it may be optimal for the authority to choose a wider band, as seems to have been the case in Brazil in June 2002. This enlargement of the band could come with some loss of utility, however, because of the lack of accuracy of the monetary policy.[34]

34. See the complete study (Bugarin and Carvalho 2005) for a detailed analysis of the model's equilibria.

Conclusion

This paper has identified the formation rule of inflation expectations in Brazil, Chile, and Mexico and tested the rationality assumption of market forecasts. Strong evidence indicates that in all countries investigated, median inflation forecasts are unbiased for short- and medium-term horizons (namely, three, six, and twelve months ahead). In Chile, median inflation forecasts for twelve months ahead are also efficient in the use of relevant economic information. In Brazil and Mexico, inflation forecasts fail at least one of the efficiency tests.

Median inflation forecasts in Brazil are efficient in the use of information on past consumer price inflation and interest rates. For short-term forecasting horizons, however, forecasters are not making good use of information on the exchange rate and wholesale price inflation. This could be associated with the fact that monetary policy only fights the second-round effects of shocks, which could increase uncertainty about where inflation is heading over short-term horizons. Median twelve-month-ahead inflation forecasts are not efficient in the use of information on the output gap. Moreover, Brazil was the only country to provide disaggregated data on inflation forecasts. Panel data estimations widely refute efficiency in inflation forecasts. Since the survey covers only professional forecasters, it is possible that people have not really reached a consensus on the nature of Brazilian inflation dynamics, and that alone may have important implications for monetary policy.

Forecasters in Mexico have been correctly using the available information on demand and supply conditions, but they could have made better use of past information on interest rates. This suggests that forecasters in Mexico have had particular difficulty understanding the model governing the relation between inflation and interest rates. Among the three countries analyzed in this study, Mexico is the only one using the monetary base, instead of interest rates, as its operational instrument.

The paper also estimated the formation rule of inflation forecasts in each of these countries. First, we carried out a principal components analysis on a very wide set of potential regressors to eliminate variables that are highly correlated with each other. Stepwise regressions were then carried out on the resulting reduced set of regressors.

In every country, inflation forecasts for a twelve-month-ahead horizon showed some adaptive behavior. That is to be expected in the particular cases of Chile and Mexico, because of the long monetary policy transmission lag.

In Brazil, the lag has been estimated at about three quarters, so credible inflation targets could perfectly anchor inflation forecasts in the investigated horizon.

As a result of strong shocks to the foreign exchange rate in 2002, inflation targets in Brazil lost much of their power to anchor inflation expectations in the last quarters of 2002 and first quarters of 2003. Inflation expectations exhibited an extreme autoregressive behavior in this period. The fact that Chile and Mexico experienced the same pressures stemming from the international environment stresses the importance of domestic conditions for the misalignment of inflation expectations in Brazil. As markets envisaged an important shift in the country's political power, uncertainties regarding the future conduct of economic policy helped external shocks feed strongly into the exchange rate. After the abrupt change in the formation rule of inflation expectations, it took forecasters one year to realign their projections with target bands.

Of the three countries analyzed here, Brazil is the only one that has not granted its central bank legal autonomy. Although central bank autonomy per se may not improve the credibility of monetary policy, an adequate institutional design for an autonomous central bank certainly minimizes uncertainty prevailing during elections.

In a companion paper, we show that the convergence of beliefs about the type of central banker has important implications for monetary policy.[35] Under reasonable assumptions regarding the weight society attributes to the future, more heterogeneous societies have to pursue a more restrictive monetary policy so as to build credibility. In relatively more homogeneous societies, the presence of an inflationary bias will require such a restrictive monetary policy.

If one believes that developing countries tend to be more heterogeneous, then the model explains why strong central bankers in those countries need to adopt tighter monetary policies to maintain credibility, as seems to have been the case in recent Brazilian monetary policy history. Therefore, a mechanism that enforced the convergence of beliefs regarding the future behavior of central bankers would be a costlier alternative to such restrictive monetary policies.

35. Bugarin and Carvalho (2005).