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Skewed Forward-Looking Monetary Policy Behavior: A Look at the Latin American Inflation Targeting Practice^{1*}

by
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Abstract

Estimation of forward-looking interest rate rules is ubiquitous in the context of developed-economy central banks. In this paper, the five countries in Latin America that have adopted the Inflation Targeting framework are considered, and estimations of forward-looking policy rules are performed via i) standard least-squares criteria and ii) quantile regressions. The estimated standard mean effects indicate that Brazil, Chile, and Mexico are strongly forward-looking for horizons of a year and more. The estimated quantile effects suggest that policy makers in Brazil, Chile, and Mexico are likely to have faced more upside than downside risks to their one-year-ahead inflation forecasts when setting their policies.

Keywords: Quantile Regressions, Monetary Policy

Introduction

The purpose of this paper is to present the results of an empirical estimate of forward-looking monetary policy behavior in five countries in Latin America that have adopted the inflation targeting (IT) regime: Brazil, Chile, Colombia, Mexico, and Peru¹.

In recent times, monetary policy in Latin America has been characterized by an evolving pattern in the use of intermediate targets and policy instruments; as a result, central banks and especially ITers² have tended to use a controllable short-term nominal interest rate as their preferred policy instrument³. This has been very important because it has allowed a better measure of monetary policy stance and has opened the possibility to perform an econometric analysis.

Regarding the management of the policy instrument, most central bankers in the world, either in developed or emerging-market countries, both ITers and non-ITers, justify forward-looking monetary policy making⁴. At the theoretical level, inflation forecasts can be considered as intermediate targets in the implementation of

forward-looking policy⁵. On the empirical side, Clarida, Gali, and Gertler (1998) and Orphanides (2001) initiated a research agenda devoted to the estimation of forward-looking interest rate feedback rules.

However, there is one dimension of analysis that has had scant attention in the empirical estimation of monetary policy reaction functions. As suggested by Goodhart (2001) and by Greenspan (2004) and King (2004), when policymakers make decisions, they pay considerable attention to the risks in the foreseeable future. Not only are the most likely or baseline forecasts important but also the low-probability, high-impact events and the nature of the shocks⁶ that shape the probabilistic distribution of forecasts.

In the discussion of FED Chairman Alan Greenspan's "Risk and Uncertainty in Monetary Policy", during the 2004 Annual Meeting of the American Economic Association, Mervin King, Governor of the Bank of England, reflected on the "risk management approach" to central banking:

Greenspan defines the [risk management] approach by saying that policy makers should look at a range of "risks" to output and inflation; and give due consideration to those risks when setting policy. He argues that policy makers cannot just rely on the forecasts from a structural model of the economy when even deep parameters are drifting. They should also use their judgment; compare current experiences with previous, similar episodes; and continually test and update a range of reduced-form models, which should help give some insight into how the economy is evolving.

This is the approach taken at the Bank of England, where the Monetary Policy Committee takes into account the entire distribution of future outcomes for inflation and output when setting interest rates. A "fanchart" for its forecasts of both inflation and output is published in the quarterly Inflation Report. (p. 43)

This is also the case amongst Latin American ITers. The systematic inclusion of balance-of-risks discussions within their inflation reports suggests that their views and decisions are somehow shaped by the outlook of risks surrounding the inflation forecast.

In light of these considerations, the aim of this paper is to estimate forward-looking behavior encompassed in the dynamics of interest rates in relation to measures of inflation forecasts. To this end, the lagged interest rate and a predetermined inflation forecast are defined as the conditioning variables that affect the interest rate setting at any given time.

First, the mean interest rate effect is assessed. In order to do so, simple linear forward-looking interest rate rules are estimated by standard ordinary least-squares techniques at different possible forecast horizons.

Second, in order to have broader information than that provided by the mean OLS estimates, quantile effects are estimated, namely, the response of the interest rate at the different quantiles of its conditioning distribution. This is done by estimating linear quantile regression models, as documented in Koenker (2005). The quantile estimates provide a broader picture of interest rate behavior and can potentially shed light on the probabilistic nature of interest responses against the backdrop of the myriad of risks Latin American ITers face.

Therefore, the technique applied in the paper provides one way to extract information from the data to characterize forward-looking behavior under both the spectrum of risks and the attitudes towards those risks that policy makers have. This is particularly important in Latin America, given the many risk factors affecting baseline inflation forecasts.

In the next section of the paper, the linear forward-looking response regression is set, and in the following section, the same is done for the quantile regression model. Thereafter, the data used in the estimations is described, and in the last section, conclusions are drawn and final observations made.

Mean forward-looking responses

The authors of empirical literature on forward-looking interest rate rules have focused primarily on developed countries. Clarida et al. (1998) and Orphanides (2001)⁷ showed, for the first time, the relevance of policy driven by future expected outcomes. In the specific context of Latin America, several country-specific studies, such as those of Restrepo (1999), Minella, Springer de Freitas, Goldfajn, & Kfoury (2003), Torres (2003), and Ramos and Torres (2005), dealt with the estimation of forward-looking policy rules for Brazil, Chile, Colombia, and Mexico.

The econometric approach for the estimation of these types of rules follows two directions. First, the GMM methodology advocated in Clarida et al. (1998), which is followed by Restrepo (1999) and Ramos and Torres (2005). The second approach pioneered by Orphanides (2001), consists in using real-time forecasts available at the time of every interest rate decision, and it is used, for example, in Jansson and Vredin (2003), Kuttner (2004), and Goodhart (2005). For the Latin American case, Ramos and Torres (2005) used forecasts from surveys instead of the countries' own central bank forecasts, while Minella et al. (2003) constructed estimates with central bank forecasts.

In this paper, this latter approach of treating forecasts directly as explanatory variables is followed more closely. As will be explained in the section on data, monthly series were used. Also, given that it is practically impossible to obtain central banks' own forecasts for the period under study, it was necessary to rely instead on consensus forecasts of private agents gathered by *Consensus Economics*. These forecasts, in the form of monthly vintages, mimic the real-time data sets used, for example, in Orphanides (2001). However, a limitation of these forecasts is that they might not be appropriate because they could, indeed, differ from central banks' own forecasts⁸. For the time being, an assumption must be made that the data set at hand captures the fundamental dynamics of central banks' own forecasts.

In all the countries under study, a relevant interbank rate is used as the monetary policy operational target (See Figure 1)⁹. This is not exactly true for Mexico, where the policy instrument is defined as the cumulative balance of commercial banks' current accounts at the central bank¹⁰. Nevertheless, according to Torres (2003), during the period under study, the interbank rate is already a good indicator of Banco de Mexico monetary policy stance.

As opposed to IT practice in advanced economies, Latin American IT still displays different degrees of convergence. Some countries are still on the way or have just converged to a stationary inflation target (See Figure 2). In such cases, the policy horizon is not clearly discernible. Others, like Chile, have explicitly announced a fixed policy horizon of more than a year. Unfortunately, the data at hand offers completed times series only up to 13-months-ahead inflation forecasts¹¹. This limits the results along the horizon dimension as responses to horizons more than 13 months

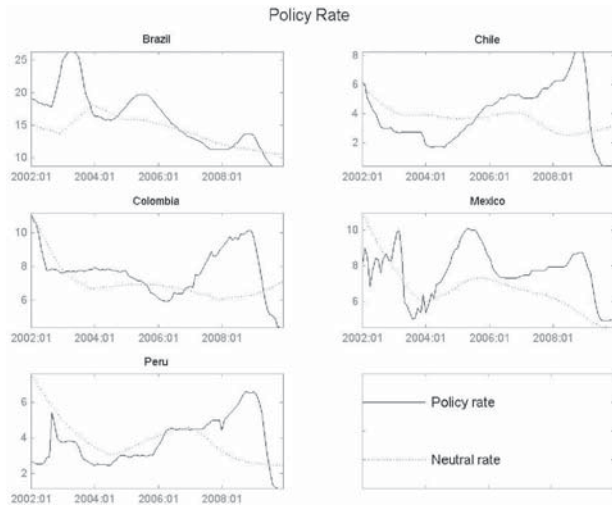


Figure 1. Policy rates and estimated neutral interest rates.

ahead cannot be calculated. Yet, the data can already show some important effects at available longer horizons.

In this study, the assumption is made that the monthly interest rate behaves according to the following equation:

$$i_t = \rho i_{t-1} + (1 - \rho) i_t^n + a_\pi (\pi_{t-1,t+h}^f - \pi_{t,t+h}^o) + \varepsilon \quad (1)$$

where i_t is the policy rate, $\pi_{t-1,t+h}^f$ is the year-on-year, h -months-ahead inflation forecast made in the month prior to the policy decision-making, $\pi_{t,t+h}^o$ is the numerical, ex-ante inflation target known at time t and to be achieved at time $t+h$, i_t^n is the neutral short-term interest rate, and ε represents all other possible sources of interest rate change¹².

To be able to diminish the bias arising from simultaneous dependence, interest rate decisions at time t depend on forecasts made before the decision (time $t-1$). However, those forecasts made at time $t-1$ implicitly assume an expected path of interest rates and a particular value of interest rates for period t that is highly correlated with period $t-1$ interest rates¹³. Therefore, a relatively strong assumption of exogeneity of last-period forecasts to the current and future interest rate decisions may be postulated.

By applying equation [1], the mean interest rate decision, conditional on information available at each decision step, can be calculated:

$$E[i_t | \Omega_t] = \rho i_{t-1} + (1 - \rho) i_t^n + a_\pi (\pi_{t-1,t+h}^f - \pi_{t,t+h}^o) \quad (2)$$

where Ω_t is the information set policy makers have before any time- t interest rate decision. This set is comprised of the lagged interest rate, the neutral interest rate, and the deviations of predetermined, last-period inflation forecast from the planned target¹⁴. It is assumed that $E[\varepsilon_t | \Omega_t] = 0$.

Quantile forward-looking responses

The key element in standard rule estimations of [2] is the use of linear regressions and the least-squares

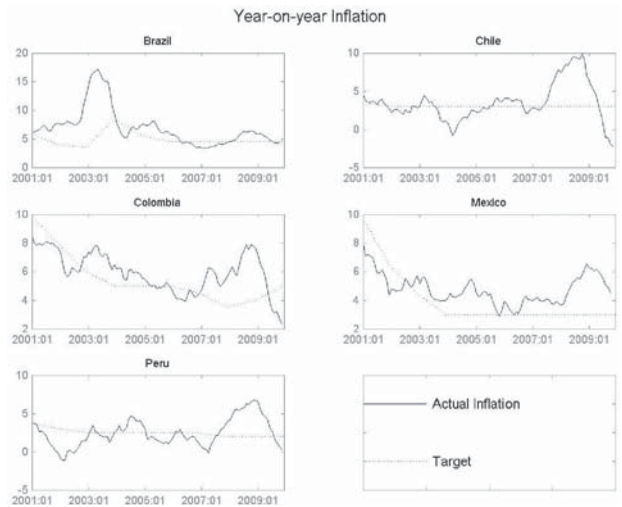


Figure 2. Inflation rates and ex-ante targets.

method to estimate what is called the *mean response* of the instrument. If the estimated errors are normal, the mean response is a good descriptor and not much else can be said. However, if the errors are not normal, Gaussian, Koenker and Bassett (1978) have shown that some features can be extracted from applying quantile regressions.

In order to set up the quantile regression framework, the model in [2] can be transformed in the following equation:

$$\bar{i}_t = \rho \bar{i}_{t-1} + \alpha \bar{\pi}_{t-1,t+h}^f + \varepsilon_t \quad (3)$$

where the variables have been transformed in $\bar{i}_t = i_t - i_t^n$ and $\bar{i}_{t-1} = i_{t-1} - i_{t-1}^n$ as interest rate deviations from their neutral values, and $\alpha = (1 - \rho) a_\pi$ together with $\bar{\pi}_{t-1,t+h}^f = \pi_{t-1,t+h}^f - \pi_{t,t+h}^o$ denoting the sensitivity of interest rates and the inflation deviations from target respectively.

The quantile regression model employs the following equation:

$$\bar{i}_t = \rho(\gamma) \bar{i}_{t-1} + \alpha(\gamma) \bar{\pi}_{t-1,t+h}^f + \varepsilon_{\gamma t} \quad (4)$$

where $\gamma \in [0,1]$ represents the orders upon which quantiles are calculated (for example, $\gamma = 0,5$ is used to calculate median effects). The distribution of $\varepsilon_{\gamma t}$ is not known; it is only assumed that the conditional quantile of the error term is $Q_\gamma(\varepsilon_{\gamma t} | \Omega_t) = 0$. Then, the conditional γ -quantile response is

$$Q_\gamma(\bar{i}_t | \bar{i}_{t-1}, \bar{\pi}_{t-1,t+h}^f) = \rho(\gamma) \bar{i}_{t-1} + \alpha(\gamma) \bar{\pi}_{t-1,t+h}^f \quad (5)$$

Koenker (2005) showed that the parameters of the regression model for any $\gamma \in [0,1]$ can be estimated by minimizing the sum of sample quantile regression functions¹⁵

$$\min_{\rho(\gamma), \alpha(\gamma)} \left\{ \frac{1}{T} \sum_{t=0}^T q_\gamma(\varepsilon_{\gamma t}) \varepsilon_{\gamma t} \right\} \quad (6)$$

where $q_\gamma(\varepsilon_{\gamma t})$ is the quantile regression weight function given by $q_\gamma(\varepsilon_{\gamma t}) = \gamma - I_{(\varepsilon_{\gamma t} < 0)}$ (note that $I_{(\varepsilon_{\gamma t} < 0)}$ is the standard

indicator function). For example, in the median case $\gamma = 0.5$, then $q_{0.5}(\varepsilon_{\gamma})$ is either $+$ or $-$ depending on the sign of ε_{γ}^1 . In that case, deviations above or below ε_{γ} are weighted similarly. In all other cases within the space $[0,1]$, deviations are weighted asymmetrically.

The minimization, and hence the estimation, of the parameters of interest relies on linear programming methods outlined first in Koenker and Bassett (1978)¹⁶. In order to obtain confidence intervals, the standard errors can be assessed by “bootstrap” methods.

The quantile regression approach outlined here is potentially useful for assessing monetary policy behavior. It can shed light on the response of interest rates at the lower and upper ends of the distribution of the inflation forecast.

For example, during the period of analysis, one might find that for a particular ITer, interest rates might react strongly at the upper end of the distribution (at the higher quantiles) but less strongly at the lower end of the distribution (at the lower quantiles). If the distribution of inflation forecasts have been such that the upper end of the distribution has been outside permissible ranges but the lower end has been mostly closed to the target, then the above finding is compatible with a central bank trying to curb upside risks. This is the asymmetric-risks interpretation related to the risk management approach quoted in the introductory section.

Another possible interpretation is that the above behavior might have been the result of an asymmetric loss function of a central bank that, given overall balanced risks, has reacted more to upper-end parts of the forecast distribution than to the lower parts. Hence, central bank behavior can be driven by asymmetric risks, asymmetric losses, or a combination of both. Unfortunately, given the available data, the sources of such behavior cannot be identified, only that the particular behavior has been present throughout the historical sample.

The data

The basic data set for each country comprises monthly series, running from 1996 onwards, of the following series: interbank interest rates, monthly series of consensus forecasts gathered by Consensus Economics, an index of economic activity¹⁷, and nominal exchange rates.

Using the nominal interest rate series, ex-post real interest rate series are constructed, which are decomposed into trend and cycle. The trend is used as a proxy for time-varying neutral real interest rates, which are then summed to corresponding inflation targets to obtain neutral nominal interest rate series to be used in the regressions.

Regarding the consensus forecast, the surveys only contain forecasts for the current and next year-end inflation rates. The survey reports are released in the second half of every month, and therefore, the current month is always part of the forecast. Given observed inflation rates within the year, the current end-year inflation forecast implies a re-

sidual inflation for the rest of the current year. Additionally, using next year-end forecasts, it is possible to construct h-month implied forecasts. Because of the pattern of the surveys, it is only possible to obtain the complete times series of 13-months-ahead implied inflation forecast.

The data set covers the period until November 2005. For the regressions, periods starting in 2000 for Brazil, mid-2001 for Chile and Colombia, and 2002 in Mexico and Peru were examined.

Results

Mean responses

In Figure 3, the different responses of the systematic part of interest rates to deviations of inflation forecasts for horizons 0 to 12 months ahead, together with their one-standard deviation confidence interval, can be observed. If the mean estimate statistically exceeds unity, then some evidence exists that the stabilizing Taylor principle applies.

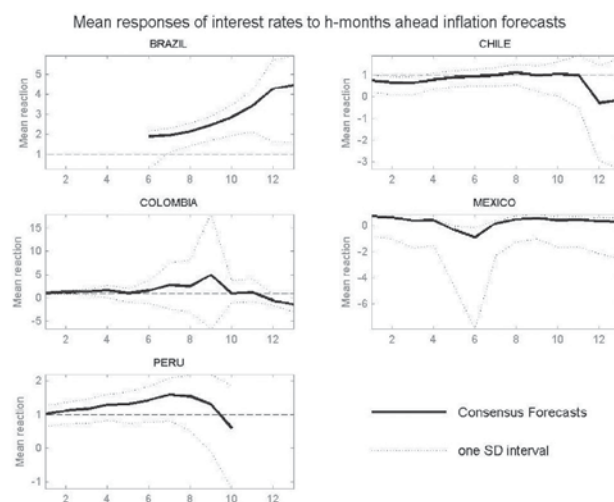


Figure 3. Mean responses of interest rates to h-months-ahead inflation forecasts.

One can observe that the responses increase as the forecast horizons rise in the cases of Brazil, Chile, and Mexico, reaching values of near or more than one for the 12-month-ahead forecasts. These results at the end horizons are in line with those reported in Minella et al. (2003) for Brazil, in Restrepo (1999) for Chile, and in Ramos and Torres (2005) for Mexico.

In the case of Colombia, the results show a very mild and statistically lower-than-one response of interest rate at the higher-end horizons. Taken at face value, this would indicate that monetary policy in Colombia might not have been responding enough to stabilize inflation. However, it should be noted that these results might reflect the fact that the consensus forecast data for Colombia might be ill-suited for the case at hand. Also, the results might reflect

the failure to adequately capture monetary policy stance throughout the whole sample.

In the case of Peru, the responses to consensus forecasts are statistically significant and close to unity up to about 7-months-ahead inflation forecasts. For longer horizons, the statistical significance vanishes. In this case, the results suggest that the monetary policy horizon in Peru has been lower than a year. This result might reflect the fact that, during the period of analysis, the policy target in Peru was set on a calendar year-end basis and not on a fixed horizon of a year or more, which is the approximate monetary control lag in Peru¹⁸.

As in the Colombian case, however, it should be noted that the result might be just the mirror of an inadequate forecast series and that the use of the own-inflation forecast might change the results significantly.

What are the lessons to be learned from these pieces of evidence? First, the results of the study presented in this paper tend to confirm previous findings of forward-looking behavior for Brazil, Chile, and Mexico. Second, the results open the question of the proper characterization

of monetary policy in Colombia and Peru within the sample: robustness, additional explanatory variables, and other factors.

Quantile responses

Table 1 shows the result for the quantile responses of interest rates to one-year-ahead inflation forecasts together with their t-values and the implied Taylor parameter.

For example, a 0.9 percentile effect (the responses on the right hand side of the panels) shows how the interest rate responds to inflation forecast deviations that are higher than the 90% of all forecast deviations, namely, the response of the interest rates at the upper tail of the inflation forecast deviation distribution. Conversely, the 0.1 percentile effect shows the responses at the lower tail. In other words, the effects at the edges of the panels show how interest rates would respond under extreme expected inflation deviations. If the forecast distributions are skewed to the right, on average, then a central bank might react statistically equal to or more or less than the mean response.

Table 1
Regressions at Different Quantiles by Country (sample 2000:01-2008:12)

	quantile	Coefficient Value	Std. Error	t value	Pr(> t)	Implied Taylor principle
BRAZIL	0.050	-0.002	0.021	-0.116	0.908	-0.041
	0.250	0.064	0.030	2.160	0.033	1.075
	0.500	0.104	0.034	3.006	0.003	1.728
	0.750	0.162	0.039	4.158	0.000	2.698
	0.950	0.302	0.036	8.320	0.000	5.032
CHILE	0.050	0.280	0.018	15.528	0.000	1.043
	0.250	0.298	0.029	10.339	0.000	1.107
	0.500	0.304	0.036	8.471	0.000	1.131
	0.750	0.309	0.029	10.756	0.000	1.149
	0.950	0.318	0.018	17.528	0.000	1.183
COLOMBIA	0.050	0.098	0.017	5.666	0.000	5.077
	0.250	0.065	0.027	2.407	0.018	3.377
	0.500	0.039	0.032	1.201	0.232	2.006
	0.750	0.006	0.026	0.231	0.818	0.310
	0.950	-0.014	0.015	-0.939	0.350	-0.740
MEXICO	0.050	-0.607	0.064	-9.441	0.000	-4.165
	0.250	-0.194	0.087	-2.242	0.027	-1.332
	0.500	0.074	0.069	1.067	0.288	0.507
	0.750	0.243	0.057	4.280	0.000	1.664
	0.950	0.411	0.044	9.340	0.000	2.818
PERU	0.050	0.608	0.053	11.557	0.000	1.304
	0.250	0.608	0.094	6.492	0.000	1.304
	0.500	0.608	0.118	5.151	0.000	1.304
	0.750	0.608	0.094	6.492	0.000	1.304
	0.950	0.599	0.053	11.384	0.000	1.286

In a completely symmetric world, one would expect the responses at all points of the distribution to be very close to the mean responses and statistically the same.

When a response is low at the lower tail and high at the upper tail, such as in the cases of Brazil, Chile, and Mexico, an interpretation can be that, provided the monetary policy loss functions are symmetric, the inflation risks during the time of observation of the sample might have been to the upside and that monetary policy has in fact reacted aggressively against those risks, even more than the median effect would suggest.

In the case of Peru, policy responses at the upper tails of the inflation forecast distribution have been generally the same as those at the lower tail. This is an indication that the Central Bank of Peru has tended to maintain a neutral balance of risks across the sample.

All in all, these results point to the fact that symmetry is not a feature of policy behavior amongst Latin American ITers. Rather, skewed risks and particular responses to them tend to deny the standard quadratic loss functions noted in the literature about optimal policy rules.

Concluding remarks

Mean and quantile response estimations of forward-looking monetary policy behavior for the five ITers in Latin America were made in the course of the study presented in this paper.

Using the mean response estimation, it was found that monetary policy behavior in these countries is forward-looking. Moreover, the use of a control lag of more than a year, suggested in the results for Brazil, Chile, and Mexico, is akin to the practice of central banks in developed countries. Possible data problems or possible shorter control lags characterize the Colombian and Peruvian cases.

The quantile regression estimates provide some key indications of the risks surrounding monetary policy decisions in these countries. Brazil, Chile, and Mexico were shown to have faced upside risks to inflation during their recent monetary policy history and these upside risks have prompted somewhat stronger interest rate responses¹⁹. Some weak evidence emerged that Peru is likely to have faced upside risk to which the authorities did not react in the expected fashion, possibly due to the short policy horizon in place.

Further research is necessary in order to relate the above findings to the institutional features of each ITer. For example, the way the central bank policy mandate is defined, the type of IT design, or the macroeconomic structure of the country might all shape the specific way monetary policy is conducted.

The above econometric assessment of forward-looking behavior is positive. An avenue of future research is to analyze the interplay between optimal policies under skewed risks conditional on a typical economic structure of Latin American inflation targeters.

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- developments in interbank markets and financial institutions, has facilitated central banks to endorse the use of interest rates instead of that of other instruments.
- 4 A perusal of Inflation Reports and formal communication from web pages of various, heterogeneous central banks easily confirms that assertion.
 - 5 See Svensson (1997).
 - 6 Their persistent or transitory features and their qualification as supply- or demand-driven shocks.
 - 7 The working paper versions both appeared in 1997.
 - 8 It is reasonable to think that central banks react basically to their internal forecasts.
 - 9 In this study, the operational target is also the policy instrument as operational issues are totally abstracted.
 - 10 Known as the 'corto'.
 - 11 Including the month when the decision is made.
 - 12 These sources of interest rate variations can be serially correlated.
 - 13 See Kim and Nelson (2004). There, it is argued that to for the exercise to be clean, the forecasts must assume a constant interest rate, so as to avoid simultaneous equation bias.
 - 14 The term "planned" target is used because, in some circumstances, such as in Brazil, targets have been adjusted ex-post. See Minella et al. (2003).
 - 15 As explained in Koenker and Bassett (1978) and Koenker (2005), this is a parallel to the ordinary least-squares minimization, where the aim is to minimize the sum of squared functions.
 - 16 See Koenker (2005) for details and more references of time series applications and quantile autoregressions.
 - 17 In the cases of Mexico and Colombia, an index of economic activity is not available; instead, monthly indices of industrial production are used,
 - 18 See Vega et al. (2009).
 - 19 The fact that the skewness of the inflation forecast distribution might affect the interest rate setting in a forward-looking central bank is explained, for example, in Goodhart (2001).

Footnotes

- 1 * The opinions herein are my own and do not necessarily correspond to the Central Bank of Peru. An earlier version of this paper was presented at the Computing in Economics and Finance Conference - 2006.
 - 1 Monetary policy options in Latin America have in general converged to the three strategies outlined in Mishkin and Savastano (2001); full-dollarization, monetary targeting, and inflation targeting (IT).
 - 2 See for example Armas and Grippa (2005), Minella et al. (2003), Landerretche et al. (1999), Restrepo (1999), and Torres (2003) for country-specific cases.
 - 3 Adoption of IT by developing countries is not the only reason. The changing structure of their economies, together with
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