

Skewed Forward-Looking Monetary Policy Behaviour: A Look at the Latin American Inflation Targeting Practice*

Marco Vega
LSE and Central Bank of Peru

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Abstract

Estimation of forward-looking interest rate rules is ubiquitous in the context of developed-economy central banks. This paper considers the five countries in Latin America that have adopted the Inflation Targeting framework and performs estimations of forward-looking rules 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.

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*The opinions herein are my own and do not necessarily correspond to the Central Bank of Peru.

1 Introduction

The purpose of this paper is to empirically estimate forward-looking monetary policy behaviour in the five countries in Latin America that have adopted the inflation targeting regime so far (IT henceforth): Brazil, Chile, Colombia, Mexico and Peru¹.

In recent times, monetary policy in Latin America has been characterised by the evolving pattern in the use of intermediate targets and policy instruments, as a result, central banks and specially 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 to have a better measure of monetary policy stance and has opened the possibility to perform econometric analysis.

Regarding the management of the policy instrument, most central bankers in the world either in developed or emerging-market countries, either ITers or 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 et.al (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 recently by Greenspan (2004) and King (2004), when policymakers take decisions, they pay considerable attention to the risks in the foreseeable future. It is not only the most likely or baseline forecasts that is important. The low-probability, high-impact events and the nature of the shocks⁶ that shape the probabilistic distribution of forecasts are also key.

In the discussion to 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, reflects 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

¹ Monetary policy options in Latin America have in general converged to the three strategies outlined in Mishkin and Savastano (2001); full-dollarisation, 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 developments in interbank markets and financial institutions have facilitated central banks to endorse interest rates instead 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.

cannot just rely on the forecasts from a structural model of the economy when even deep parameters are drifting. They should also use their judgement; 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 "fan chart" for its forecasts of both inflation and output is published in the quarterly Inflation Report.

This is also the case within 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 behaviour encompassed in the dynamics of interest rates in relation to measures of inflation forecasts. To this end, we define the lagged interest rate and a predetermined inflation forecast as the conditioning variables that affect the interest rate setting at any given time.

First, we are interested in the mean interest rate effect. 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 a broader information than that provided by the mean OLS estimates, we perform the estimation of quantile effects; 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 behaviour 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 characterise forward-looking behaviour under both the spectrum of risks and the attitudes towards those risks policy makers have. This is particularly important in Latin America, given the many risk factors affecting baseline inflation forecasts.

The paper proceeds as follows, in section 2 we set the linear forward-looking response regression, in section 3 we do so for the quantile regression model, in section 4 we describe the data used in the estimations, and in section 5 we conclude with final remarks.

2 Mean forward-looking responses

The 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 like Restrepo (1999), Minella et.al (2003), Torres (2003) and Ramos and Torres (2005) deal with the estimation of forward-looking policy rules for Brazil, Chile, Colombia, and Mexico.

The econometric approach for the estimation of these type 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) use forecasts from surveys instead of own-central bank forecasts while Minella et.al (2003) construct estimates with central bank forecasts.

In this paper we follow more closely this latter approach of treating forecasts directly as explanatory variables. As it will be explained in section 4, we use monthly series. Also, given that it is practically impossible to obtain central banks' own forecasts for the period under study, we 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, we reckon that these forecasts might not be appropriate because they might indeed differ from central banks' own forecasts⁸. For the time being, we need to assume that the data set at hand captures the fundamental dynamics of central banks' own forecasts.

In all the countries under study we use a relevant interbank rate 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 apposed 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, our data at hand allow us to have complete times series only up to 13-months-ahead inflation forecasts¹¹. This will limit our results

⁷ The working paper versions appeared both 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 taken.

along the horizon dimension as responses to horizons more than 13 months ahead can not be calculated. Yet, the data can already show some important effects at available longer horizons.

In this study we assume that the monthly interest rate behaves according to the following equation

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

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 the policy decision is taken, $\pi_{t,t+h}^o$ 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_t 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 we postulate a relatively strong assumption of exogeneity of last-period forecasts to the current and future interest rate decisions.

According to equation [1] we can calculate the mean interest rate decision conditional on information available at each decision step

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

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

3 Quantile forward-looking responses

The key element in standard rule estimations of [2] is the use of linear regressions and the least squares method to estimate what we call the mean response of the instrument. If the estimated errors are normal, the mean response is a good descriptor and not much

¹² This 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, to avoid simultaneous equation bias

¹⁴ We use de term "planned" target because in some circumstances such as Brazil, targets have been adjusted ex-post. See Minella et.al (2003).

else can be said. However, if the errors are not gaussian, Koenker and Bassett (1978) show that some features can be extracted from applying quantile regressions.

In order to setup the quantile regression framework, the model in [1] can be transformed in:

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

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

The quantile regression model considers:

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

Where $\gamma \in [0, 1]$ represents the orders upon quantiles are calculated (for example, when $\gamma = 0.5$ we calculate median effects). The distribution of $\varepsilon_{\gamma t}$ is not know, 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

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

Koenker (2005) show that the parameters of the regression model for any $\gamma \in [0, 1]$ can be estimated by minimising 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 $\gamma = \frac{1}{2}$ then $q_{0.5}(\varepsilon_{\gamma t})$ is either $\frac{1}{2}$ or $-\frac{1}{2}$ depending on the sign of $\varepsilon_{\gamma t}$. In that case, deviation above or below $\varepsilon_{\gamma t}$ are weighted similarly. In all other cases within the space $[0, 1]$, deviations are weighted asymmetrically.

The minimisation 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 get confidence intervals, the standard errors can be obtained by bootstrap methods.

¹⁵ As explained in Koenker and Bassett (1978); Koenker (2005), this is a parallel to the ordinary least squares minimisation where the aim is to minimise the sum of squared functions.

¹⁶ See Koenker (2005) for details and more references of time series applications and quantile autoregressions.

The quantile regression approach outlined here is potentially useful for assessing monetary policy behaviour. 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 we 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 have been outside permissible ranges but the lower end have been mostly closed to the target then the above finding is compatible with a central bank trying to curve 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 behaviour might have been the result of an asymmetric loss function of a central bank that, given overall balanced risks, have reacted more to upper end parts of the forecast distribution than to the lower parts. Hence central bank behaviour can be driven by asymmetric risks, asymmetric losses or a combination of both. Unfortunately, given the available data we can not identify the sources of such a behaviour, only that the particular behaviour has been present throughout the historical sample.

4 The Data

Our 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, we construct ex-post real interest rate series which are then decomposed in 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 forecast for the current and next year-end inflation rates¹⁸. The survey reports are released on 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 imply a residual inflation for the rest of the current year. Additionally using next year-end forecasts, it is possible to construct h-month implied forecasts. Given the pattern of the surveys, it is only possible to obtain complete times series of 13-months ahead implied inflation forecast.

¹⁷ For the case of Mexico and Colombia we do not have an index of economic activity, instead we use monthly indices of industrial production

¹⁸ See figures 3 and 4 where these series are plotted. Minor interpolation is done there to complete missing data.

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

5 Results

5.1 Mean responses

On figure 5 we observe 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. If the mean estimate statistically exceeds unity then we have some evidence that the stabilising Taylor principle applies.

We observe that the responses increase as the forecast horizon rise in the case 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, and Restrepo (1999) for Chile and 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 stabilise inflation. However, we should warn that these results might reflect the fact that the consensus forecast data for Colombia might be ill-suited for the case at hand. Also, it 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 Peru ¹⁹.

As in the Colombian case, however we warn 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 in a significant way.

What are the lessons to be learned from this pieces of evidence? First the paper tends to confirm previous findings of forward-looking behaviour for Brazil, Chile and Mexico. Second, it opens the question of the proper characterisation of monetary policy in Colombia and Peru within the sample; robustness, additional explanatory variables, etc.

¹⁹ See Central Bank of Peru (2005)

5.2 Quantile responses

Figure 6 depicts 5 panels showing the quantile responses of interest rates to one-year-ahead inflation forecasts together with the mean responses and their respective 95 percent confidence intervals. For the case of Peru we have considered 7 months ahead inflation forecasts because this is the relevant horizon reflected in the data.

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 percent 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 more, equal or less than the mean response.

In a completely symmetric world, we 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 the case of Brazil, Chile and Mexico we can interpret that - provided that the monetary policy loss functions are symmetric - the inflation risks during the sample might have been to the upside and that monetary policy have in fact reacted aggressively against those risks, even more than the median effect would suggest.

For the case of Peru, policy responses at the upper tails of the inflation forecast distribution have been lower than the mean responses. This is an indication that the Central Bank of Peru have tended not to strongly respond to upside risks to their inflation forecasts. With such a low policy horizon (7 months), upside risk balances reflect inflationary factors to which it is not desirable to respond aggressively.

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

6 Concluding remarks

We have performed mean and quantile response estimations of forward-looking monetary policy behaviour for the five ITers in Latin America.

Using the mean response estimation we have found that monetary policy behaviour 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 characterise the Colombian and Peruvian case.

The quantile regression estimates give us some key directions of the risks surrounding monetary policy decisions in these countries. We have interpreted that Brazil, Chile and Mexico have faced upside risks to inflation during their recent monetary policy history and that these upside risks have somewhat prompted stronger interest rate responses²⁰. We find some weak evidence 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 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 behaviour is positive. An avenue of future research is to analyse the interplay between optimal policy under skewed risks conditional on a typical economic structure of Latin American inflation targeters.

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²⁰ 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).

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Various issues of *Latin American Concensus Forecasts* produced by Concesus Economics. *Inflation Reports* downloaded from central bank web pages.

Figure 1: Policy rates and estimated neutral interest rates



Figure 2: Inflation rates and ex-ante targets

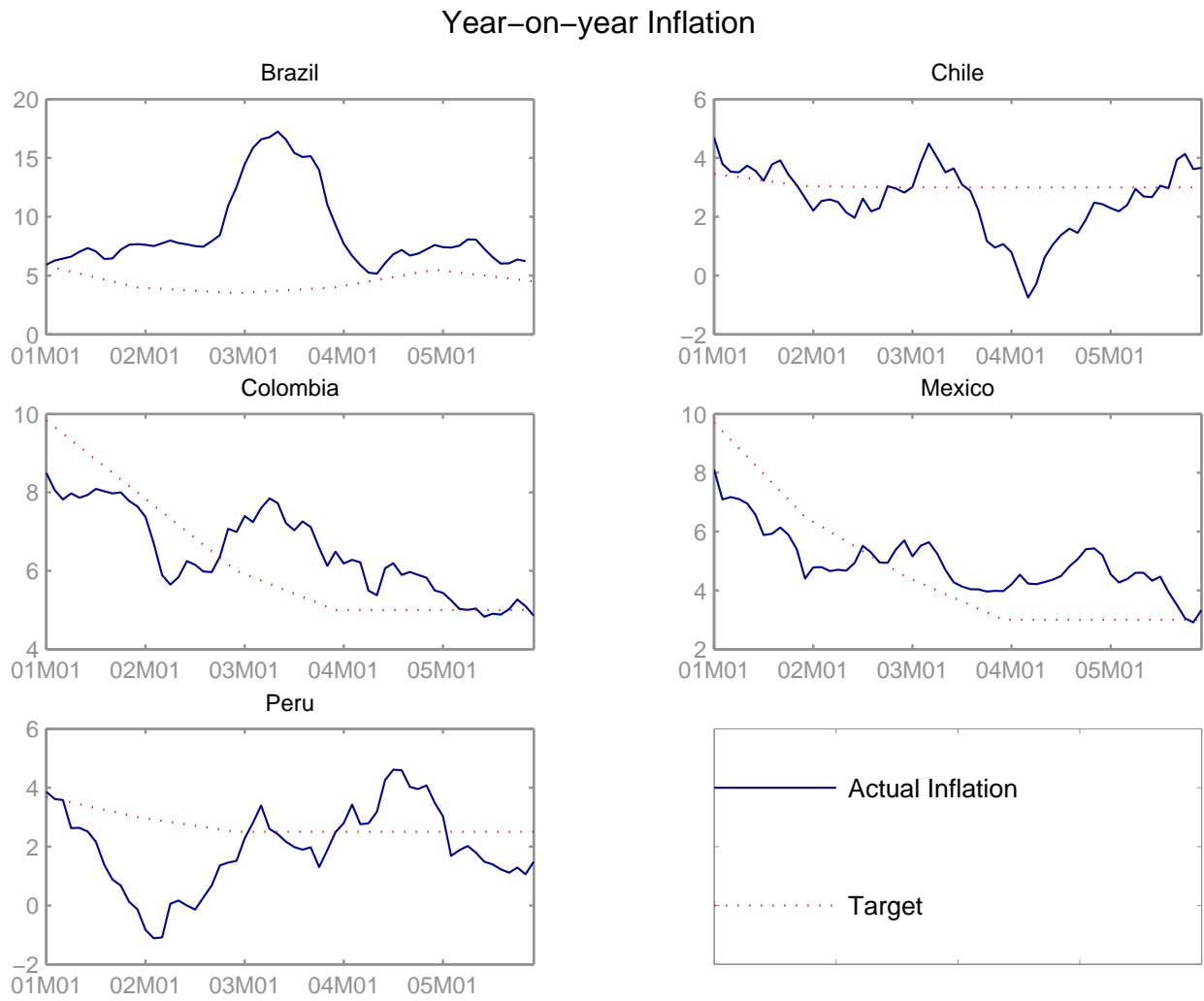


Figure 3: Current year-end consensus forecasts: Dotted lines are the actual data and continuous lines are interpolated data for missing observations

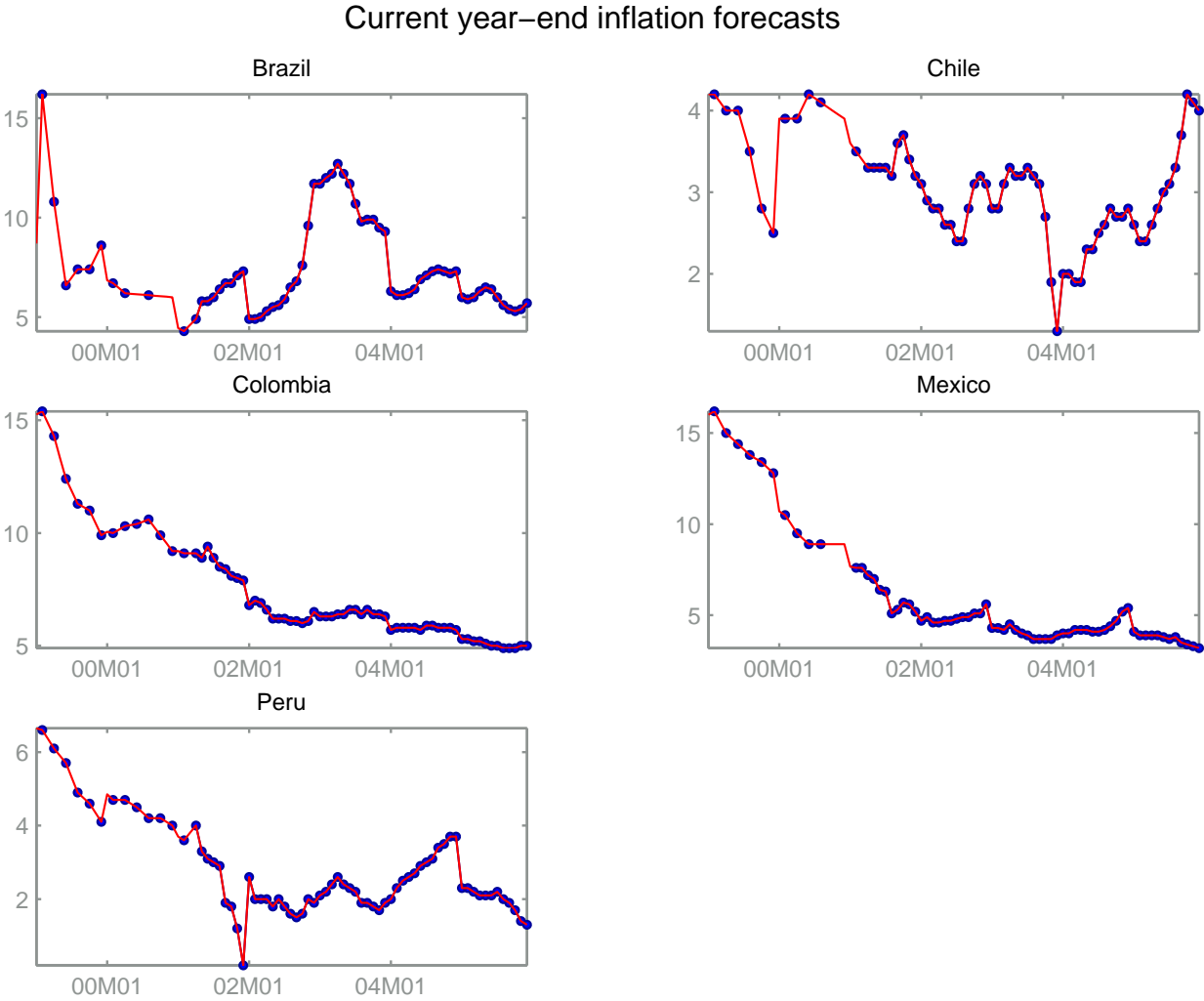


Figure 4: Next year-end consensus forecasts: Dotted lines are the actual data and continuous lines are interpolated data for missing observations

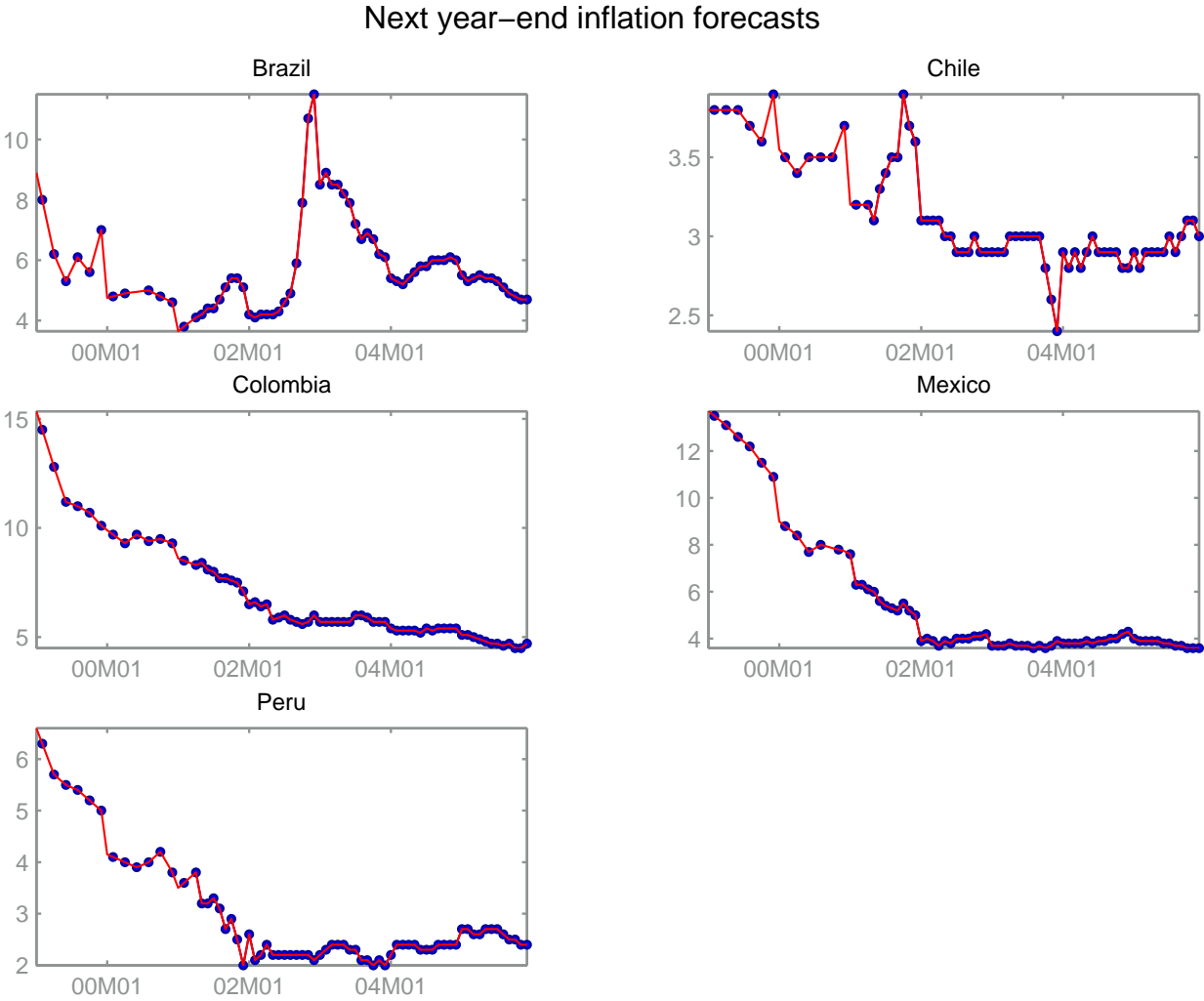


Figure 5: Mean responses to h-period ahead inflation forecasts

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

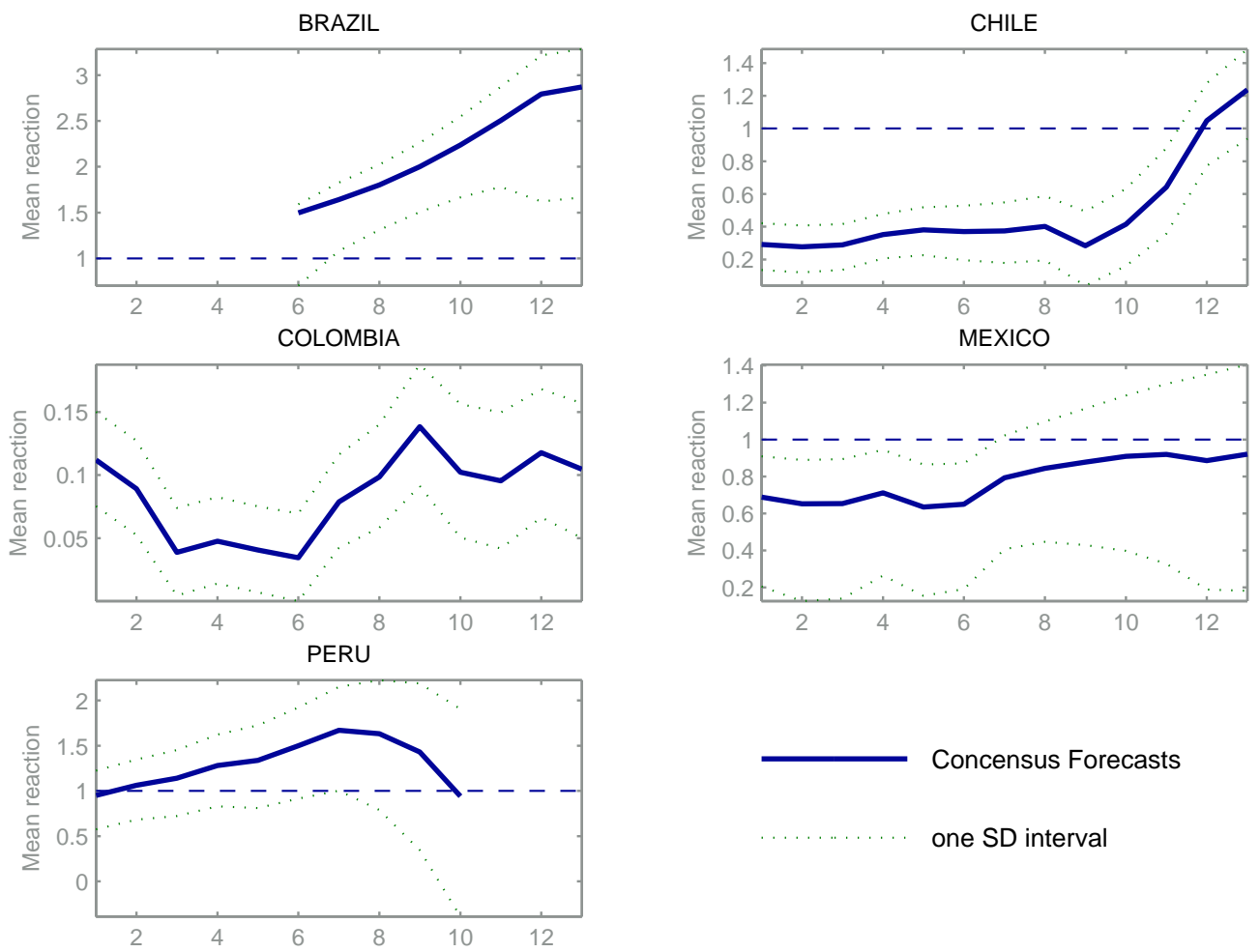


Figure 6: Quantile responses to relevant forecast horizons

