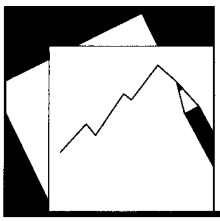
WP/11/209



IMF Working Paper

Communication of Central Bank Thinking and Inflation Dynamics

Man-Keung Tang and Xiangrong Yu

INTERNATIONAL MONETARY FUND

 WP/11/209

IMF Working Paper

Western Hemisphere Department

Communication of Central Bank Thinking and Inflation Dynamics

Prepared by Man-Keung Tang and Xiangrong Yu[1]

Authorized for distribution by Martin Kaufman

August 2011

Abstract

This paper studies the role of central bank communication of its economic assessment in shaping inflation dynamics. Imperfect information about the central bank's assessment—or the basis for monetary policy decisions—could complicate the private sector's learning about its policy response function. We show how clear central bank communication, which facilitates agents' understanding of policy reasoning, could bring about less volatile inflation and interest rate dynamics, and afford the authorities with greater policy flexibility. We then estimate a simple monetary model to fit the Mexican economy, and use the suggested paramters to illustrate the model's quantitative implications in scenarios where the timing, nature and persistence of shocks are uncertain.

JEL Classification Numbers: E31; E37; E52; E58

Keywords: Information asymmetry; expectations; inflation dynamics; monetary policy

Authors' E-Mail Addresses: mtang@imf.org; xyu@ssc.wisc.edu

[1] We would like to thank Enrique Flores, Vikram Haksar, Martin Kaufman, David J Robinson, staff at the Banco de México, and participants of IMF WHD seminar for their very useful and constructive comments. All remaining errors are ours. Part of this paper was written when Yu was an IMF intern—he gratefully acknowledges the kind hospitality and stimulating work environment at the Fund.

Contents Page

I. INTRODUCTION

Being the monopolistic decision maker on such key economic levers as short-term interest rates and money supply, central banks hold great sway over the speed—and occasionally even the direction—of the course of the economy.[2] Their importance prompts investors and individuals alike to devote significant resources trying to divine their thinking and anticipate their move. Nevertheless, it has not always been the case that central banks are forthcoming about their views and intentions. Not very long ago, some central banks even deliberately shrouded their thinking in secrecy and denied the private sector opportunities to gain better understanding of their policy decisions.[3]

More recently, however, amidst a general rise in central bank autonomy, central banks around the world have been establishing clearer communications and moving toward greater transparency, in part reflecting a larger need to become accountable in exchange for the privilege of increased independence. The strengthening in information provision has been taking place also in the context of growing macro-financial linkages, as central banks recognize the increasing importance to guide the pricing of financial assets which are dependent on interest rate expectations, and to avoid generating big policy surprises that may roil the markets. And indeed, consistent with the view that central bank transparency complements financial deepening, cross-country evidence shows that countries with more developed financial system tend to have more transparent central banks (e.g., Dincer and Eichengreen, 2007; BIS, 2009).

More broadly, in explaining their policy intentions and managing expectations, communications by central banks could strengthen the effectiveness of monetary policy through reducing policy uncertainty, expanding the dimension of their operational instrument,[4] and enhancing their credibility and the private sector's understanding of their response function. While communications to the private sector is typically not an official central bank policy tool and a high degree of transparency could in theory be counterproductive (e.g., D'Amato et al., 2002),[5] existing empirical studies generally find that central bank communications matter for economic behaviors (e.g., Kohn and Sack, 2004;

---

[2] Central banks of course also influence the economy through tools other than short-term interest rates and money supply (e.g., qualitative and quantitative easing, FX intervention).

[3] For instance, in the U.S., Alan Greenspan was well-known in the past for his preference for ambiguity. In a much-cited remark from his Senate testimonial in 1987, Greenspan said, "Since becoming a central banker, I have learned to mumble with great incoherence. If I seem unduly clear to you, you must have misunderstood what I said."

[4] For instance, through communicating their policy intentions regarding the future short-term interest rates, central banks can affect also the current longer-term rates.

[5] Some often-cited potential drawbacks of central bank transparency include: central bank communications may be misinterpreted; it is difficult to accurately communicate the wide spectrum of views held by the different policy committee members; and more information made available by the central bank might crowd out the private sector's incentives to generate information.

Ehrmann and Fratzscher, 2007), and that they tend to lead to more favorable economic outcomes (e.g., Fujiwara, 2005; Rozkrut et al., 2007; Garcia-Herrero, 2008).

It is important, however, to distinguish the different aspects of transparency. Two that have been often discussed in the literature and policy circle are related to the central bank's price stability commitment and to its policy intentions. On the first, the central bank may explicitly express its policy objective vis-à-vis inflation, including through a formal adoption of inflation targeting mandate. On the second, the central bank may provide hints of varying strength about its future policy actions, thus actively managing the level and precision of the private sector's interest rate expectations.[6]

This paper focuses on another aspect of transparency—namely, an effective communication by the central bank of its economic assessment that serves as the basis for its policy decisions. As different agents possess different information sets or may interpret the same data differently, it is likely that not all of them have identical ideas about the future state of the economy. Considerable dispersion in agents' economic view exists even in countries where wide array of economic data are publicly available and information sharing is prevalent (e.g., Mankiw et al. 2003 on the U.S.). In fact, even within the monetary policy committee where members are presented identical information, there could still be nontrivial disagreement on the economy (e.g., Banternghansa and McCracken 2009 on the U.S.'s FOMC). In a central bank-private sector bilateral setting, potential differences in economic assessment between the two parties point to possible benefits from two-way communications. In practice, information about the private sector's views is usually widely available from not only market sources but also regular surveys—indeed many central banks actively gauge the private sector's views through detailed questionnaires. In contrast, the private sector is largely only passive receiver of information from the central bank, and the central bank has full control over the degree of details about its views to disseminate to the private sector. Regular central bank reports, policy minutes, press conference, and policy member speeches are the usual avenues through which central banks can express their economic outlook and explain the thinking underlying their policy decisions and intentions, although the frequency, clarity and granularity of the presentation differs from one central bank to another (e.g., Fracasso et al., 2003).

Imperfect communication on this aspect could have important implications for economic dynamics, even for a central bank with strong credibility regarding its medium-term inflation objective. It is unlikely that the private sector is clear about the precise response function of the central bank—although one could ex-post estimate a quantitative rule to explain a central bank's decisions, such an exercise typically yields a relatively small measure of fit or R-squared, highlighting the difficulty for the private sector to learn about the central bank's

[6] A prominent example is the recent series of strong signals sent by the U.S. Federal Reserve about keeping interest rates low for an extended period of time has firmly anchored the market's interest rate expectations for the near term.

response function.[7] In this context, uncertainty about the central bank's economic assessment (or the reasons driving its policy decisions) could lead the private sector to misinterpret the central bank's response function, which would in turn affect their (near-term) inflation and output expectations and hence even the current-period economic outcomes in a forward-looking setting.

This paper builds an analytical framework to explore such economic implications and underscore the importance of central bank communications about its economic outlook. Specifically, when faced with the twin uncertainties about the central bank's economic assessment as well as about its response function, the private sector is assumed to update its prior beliefs in a Bayesian fashion. The posterior belief about the central bank's response function would form a basis for the private sector's forecasts of future monetary policy, output and inflation. Assuming that the private sector is forward-looking, these forecasts would feed into the private sector's current behaviors, impacting the inflation and output dynamics in the short term, even if they revert back to equilibrium in the medium term.

A quantitative evaluation of the framework is shown through several stylized scenarios, based on a simple monetary model with parameters similar to those suggested by data for Mexico. Given the well-anchored medium-term inflation expectations in Mexico, the quantitative exercise calibrated to hypothetical data that are largely derived from Mexico helps emphasize the importance of central bank communication about its outlook even for central banks that have solid credibility regarding the medium-term inflation. In addition, the calibrated exercise serves to illustrate some of the potential benefits that could arise from the recent significant efforts to advance central bank communications in Mexico.

In particular, in situations where the central bank's inflation outlook is more benign than the private sector's, imperfect communication by the central bank is shown to have the potential of giving rise to a higher inflation and interest rate volatility. The underlying rationale is simple: the central bank would tend to maintain low interest rates given its benign inflation assessment; yet upon observing the muted response to what the private sector believes to be an unfavorable inflation outlook, the private sector would misinterpret the central bank as overly dovish and hence expect a higher inflation in the next period, which would then push up the current inflation. In response, meanwhile, the central bank would need to increase interest rates by more than in the case of perfect communication. The exercise's result that better communication on its outlook could help the central bank achieve more stable inflation is consistent with the existing statistical empirical literature (e.g., Minegishi and Cournede, 2009, and Dincer and Eichengreen, 2009) on the effect of general central bank transparency.[8] Separately, the exercise highlights the benefits of the central bank being forthcoming about

[7] It is worth emphasizing that uncertainty about the central bank's response function does not necessarily imply a lack of central bank credibility to maintain price stability (or keep inflation at the target) or unanchored medium-term inflation expectations.

[8] In addition, unlike e.g., Erceg and Levin (2003), the exercise does not show that greater communications can help substantially reduce inflation persistence—this (lack of) result is also in line with the finding of Minegishi and Cournede's (2009) empirical study.

its economic assessment even if it turns out to be mistaken, providing a counterpoint to the view that central banks should maintain low transparency to avoid revealing any policy mistakes.

The remainder of this paper is organized as follows. This introduction will end with a brief review of related existing literature. Section II describes the model, which is an extension of the standard New Keynesian framework. Section III provides short descriptions of Mexico's inflation regime and the Mexican data, and presents results of an estimation of the monetary model for Mexico. Section IV contains the quantitative simulation exercise. And Section V concludes.

Literature Review

The role of the central bank in managing expectations has been explored in the New Keynesian literature; see Blinder (2000), Clarida et al (1999), King et al (2008), Walsh (2010), and Woodford (2003) for examples. In these studies, due to the forward-looking behaviors of the agents determined by their intertemporal decisions, the effectiveness of monetary policy depends as much on the private sector's expectations about future policy as upon the central bank's actual actions. These expectations channels highlight the potential gains from central bank credibility and commitment.

The assumption of perfect and symmetric information underlying these canonical models, however, runs into tension with some empirical regularities. First, agents do not always seem to share the same information and have homogenous expectations (e.g., Capistrán and Timmermann (2009), Mankiw et al (2003), and Pesaran and Weale (2006)); similarly, central banks seem to face a great deal of uncertainty about how private expectations are formed (e.g., Brock et al (2007), Orphanides and Williams (2007)). Second, standard perfect information models generally do not seem to match the observed behaviors of macroeconomic aggregates (e.g., Milani, 2007a).

To address these difficulties, alternative notions of expectation have been proposed in the literature. One example is the heterogeneous expectations approach pioneered by Brock and Hommes (1997, 1998). They assume that the relevant expectations are aggregated from individual agents' beliefs, which individuals choose from several available distinct predictors according to a discrete choice model. The fraction of the users of each predictor evolves each period when new information is available so that each predictor's accuracy in matching the data is reevaluated, and then the aggregate expectations adjust accordingly. This type of endogenously time-varying expectations has been recently incorporated into the New Keynesian framework for policy study; examples include Berardi (2009), Branch and McGough (2009), Branch and Evans (2010) and De Grauwe (2010). Another prominent approach is perpetual learning, where it is assumed that agents do not know the true parameters of the model, but instead continuously reestimate a forecasting model (typically some VAR system). Sargent (1999) and Evans and Honkapohja (2001) give excellent expositions of this method. As put by Orphanides and Williams (2007), this form of learning represents a relatively modest, and arguably realistic, deviation from rational expectations. The literature of applying perpetual learning to monetary policy is growing with recent

examples such as Collard and Dellas (2004), Gaspar et al (2006), Milani (2007a), Nunes (2009), and Orphanides and Williams (2006, 2007), among many others.

This paper's approach follows the spirit of these learning models. However, in order to yield sharper specific focus on the role of imperfect information about the central bank's response function and about the outlook assessment but also to avoid major departures from rational expectations, our framework does not assume complete model uncertainty per se. Instead, it assumes that the private sector is uncertain—and thus needs to learn—only about the central bank's responsiveness inflation in an environment with unobserved macroeconomic shocks (to output, and inflation); but the private sector and the central bank are assumed to have perfect information about the rest of the structure of the economy (i.e., the parameters of the equations governing inflation and output).

The importance of central bank communications to reduce information barrier has been studied in a sizable literature (Eusepi and Preston (2010), Faust and Svensson (2001), Rudebusch and Williams (2008), and Woodford (2005); see also Blinder et al (2008) for an excellent overview on the theory and practice of central bank transparency). Much of the literature, however, considers communications largely as a tool to increase predictability of future monetary policy decisions. Important exceptions include Erceg and Levin (2003), Orphanides and Williams (2006, 2007), Aoki and Kimura (2008), and Alichi et al. (2009), who focus on transparency about the central bank's otherwise unobserved or non-credible inflation target. This paper complements the existing central bank communication literature by showing that transparency about the central bank's outlook assessment (or rationales behind its policy decisions)—even when it turns out to be false--could enhance the effectiveness of monetary policy.

This paper is also related to the literature estimating structural macroeconomic models for Mexico. For instance, Ramos-Francia and Torres (2006) investigate the dynamics of inflation in Mexico from 1992 to 2006 and find that the hybrid New Keynesian Phillips curve fits the Mexican data well. Based on a similar framework but expanding it to a simple reduced-form monetary system, this paper obtains Phillips curve estimates—which are comparable to Ramos-Francia and Torres's results--as well as those for a simple IS equation and monetary policy rule using Mexican data. Separately, Chiquiar et al (2008) assess the effect of Mexico's adoption of inflation targeting framework in the early 2000s. The authors detect a significant change in the degree of persistence exhibited by Mexican inflation around the time of regime shift, with inflation switching from a nonstationary to stationary process. Their results suggest that the channel through which transparency about the inflation target could benefit the inflation dynamics—as highlighted by Erceg and Levin (2003), etc.—might have been at work in Mexico.

II. THE MODEL

We consider a simple New-Keynesian style macroeconomic model which consists of structural equations:

$$\pi_t = (1-\theta)\beta E_t^{PS}\pi_{t+1} + \theta\pi_{t-1} + \kappa x_t + u_t^{\pi} \tag{1}$$

$$x_t = (1-\phi)E_t^{PS}x_{t+1} + \phi x_{t-1} - \gamma(i_t - \iota - E_t^{PS}\pi_{t+1}) + u_t^{x}, \tag{2}$$

where x_t is the output gap (difference between the logs of actual and potential output) at time t, π_t is the inflation rate (expressed as a deviation from its long-run level), i_t is the nominal interest rate, and ι is the equilibrium real interest rate that is assumed to be constant over time. The operator E_t^{PS} stands for the private sector's forecast of the corresponding variable given all information available at t, and it is not necessarily the mathematical conditional expectation. We assume that supply shocks u_t^{π} and demand shocks u_t^{x} are contemporarily and serially independent and subject to the normal distributions of zero mean and variances σ_{π}^2 and σ_x^2.

Equation (1) is a New Keynesian Phillips curve representing the aggregate-supply relation in the economy. It evolves from the optimal price-setting behavior of firms under the assumptions of monopolistic competition and nominal rigidity, as exemplified in the classic Calvo (1983) pricing model. We allow for some degree of backward-looking, $\theta\pi_{t-1}$, to capture the persistence of inflation observed in the data; see, for example, Benati (2008) for general evidence and Chiquiar *et al* (2008) for the Mexican experience. This endogenous persistence arises when a fraction of firms adjust their prices according to an indexation rule. Equation (2) is the intertemporal IS relation, emerged from the optimal decision of households by linearizing the Euler equation. Again, partial adjustment of x_t is allowed by the backward-looking term ϕx_{t-1}, which can be justified by habit persistence in private expenditure. All these elements are standard in the New Keynesian framework as exposited in Walsh (2010) and Woodford (2003).[9]

As a welfare measure to guide the policy choice, the central bank's (CB) objective is to stabilize output and price in the sense of minimizing their unconditional variances

$$L = \text{var}(\pi_t) + \lambda\,\text{var}(x_t)\,. \tag{3}$$

[9] The model could be extended to the open economy by including the exchange rate pass-through to prices and imposing a real uncovered interest rate parity (UIP) condition. However, as the empirical evidence from the Mexican data shows below, this extension is not quantitatively important. The data also confirm that autocorrelations in the shocks can be assumed away.

This loss function is timeless in the sense of Woodford (2003) and thus avoids problems of time inconsistency. Relative weight $\lambda > 0$ reflects the conflicting policy goals and the tradeoff that the CB has to make in policymaking.

We assume that the CB follows a Taylor (1993) - type linear interest rate rule that responds to the current output gap and the expected future inflation

$$i_t = gx_t + qE_t^{CB}\pi_{t+1} \tag{4}$$

where E_t^{CB} represents the CB's expectation. Unlike Taylor's original feedback rule, specification (4) is an inflation-forecast-based rule: the CB looks into the future and reacts to anticipated inflation. This feature is empirically relevant to the inflation targeting regimes in which the conduct of monetary policy is highly forecast-based. In the literature, the forward-looking rules are advocated by Batini and Haldane (1998) and Clarida *et al* (1998) and also applied to the policy exercises with learning behaviors by Orphanides and Williams (2007).[10] It is in this context of forward-looking policymaking that information asymmetry about the CB's outlook assessment can have important implications for the economic dynamics.

Now let us turn to describing the information structure of the model economy. First, we assume that the CB and the private sector may not have identical views on future inflation, up to a stochastic difference, i.e.,

$$E_t^{PS}\pi_{t+1} = E_t^{CB}\pi_{t+1} - v_t, \tag{5}$$

where v_t is white noise with mean zero and variance σ_v^2.[11] In our setting, the difference in their inflation outlook mainly arises from a difference in their belief about the properties of the current or future shocks to the system (as will be discussed in greater details in the simulation exercise in section IV). In reality, many central banks do publish their macroeconomic forecasts. Nevertheless, to the extent that the forecasts are conditional on assumptions that are not fully specified, information asymmetry would still exist regarding the CB's precise views on future inflation.

Given asymmetric assessments of future inflation (5), the interest rate rule (4) can be rewritten as

$$i_t = gx_t + qE_t^{PS}\pi_{t+1} + qv_t \tag{6}$$

[10] The forward-looking rules may be susceptible to indeterminacy of rational expectations equilibria as shown by Bernanke and Woodford (1997), but it is not a problem under our calibration.

[11] As we propose no micro-founded theory about how the central bank and the private sector form their economic outlook (which is beyond the scope of this paper), for simplicity we avoid imposing a richer structure on *v*.

The policy rule (6), along with structural equations (1) and (2), forms the true model that governs the economy.

To make the problem interesting and more realistic, we allow for another source of information asymmetry—namely, the private sector is not certain about the CB's policy rule. After all, as noted by Clarida *et al* (1999, p. 1671), "in practice, no major central bank makes any kind of binding commitment over the course of its future monetary policy", and neither do central banks tend to follow any fixed mechanical rules. In particular, we assume that the private sector is uncertain about q, the CB's responsiveness to inflation. With uncertainty also about $E_t^{CB}\pi_{t+1}$(or v_t), the private sector hence needs to learn imperfectly, though rationally, about the true parameter q upon observing the CB's interest rate decision, *i*.

It is important to note that the model abstracts from some other possible channels through which CB communications affect macroeconomic outcomes. For instance, to the extent that the CB has superior information and analytical ability, clearly communicating its views could guide the private sector to form more accurate and precise expectations. Such channels are discussed in other studies (e.g., Kohn and Sack, 2004; and Andersson el al., 2006).

The timing of the model is as follows. The private sector has a prior belief about $q \sim N\left(\hat{q}_{t|t-1}, \sigma_q^2\right)$ and the private sector and the CB each carries its own view on the sequence of macro shocks $\{u_i^{\pi}, u_i^{x}\}_{i=t}^{\infty}$ when they enter into period t. Then $\{i_t, \pi_t, x_t, E_t^{PS}x_t, E_t^{PS}\pi_t\}$ would be solved through recursive interactions between the following two processes:

(i) *Solving backward the model*, following Sim's (2002) approach to linear rational expectations system. Specifically, define a vector of prediction errors $\eta_t = p_t - E_{t-1}^{PS}p_t$, for $p_t \equiv \left[\pi_t \quad x_t\right]'$, and then express the model in the vector form

$$\Gamma_0 y_t = \Gamma_1 y_{t-1} + C + \Psi z_t + \Pi \eta_t,$$

Where

$$y_t = \begin{bmatrix} \pi_t \\ x_t \\ i_t \\ E_t^{PS}\pi_{t+1} \\ E_t^{PS}x_{t+1} \end{bmatrix}, \quad z_t = \begin{bmatrix} u_t^{\pi} \\ u_t^{x} \\ v_t \end{bmatrix}, \quad \eta_t = \begin{bmatrix} \eta_t^{\pi} \\ \eta_t^{x} \end{bmatrix}, \quad \Gamma_0 = \begin{bmatrix} 1 & -\kappa & 0 & -(1-\theta)\beta & 0 \\ 0 & 1 & \gamma & -\gamma & -(1-\phi) \\ 0 & -g & 1 & -\hat{q}_{t|t-1} & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{bmatrix},$$

$$\Gamma_1 = \begin{bmatrix} \theta & 0 & 0 & 0 & 0 \\ 0 & \phi & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}, \quad C = \begin{bmatrix} 0 \\ \gamma\iota \\ \iota \\ 0 \\ 0 \end{bmatrix}, \quad \Psi = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & \hat{q}_{t|t-1} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \quad \Pi = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}.$$

The solution to this system is given as

$$y_t = \Theta_1 y_{t-1} + \Theta_c + \Theta_0 z_t + \Theta_y \sum_{s=1}^{\infty} \Theta_f^{s-1} \Theta_z E_t^{PS} z_{t+s}\,, \tag{7}$$

with all Θ matrices defined the same way as in Sims (2002). The private sector's expectations, $E_t^{PS}\pi_{t+1}$ and $E_t^{PS}x_{t+1}$, are implicitly determined as a part of the solution (7).[12]

(ii) *Updating the belief about q in a Bayesian fashion*. Rewriting (6) as

$$q = \frac{i_t - g x_t - q v_t}{E_t^{PS}\pi_{t+1}}$$

To simplify computation, we assume that the private sector considers the term qv_t as i.i.d. normal with zero mean and known variance $q^2\sigma_v^2$ (even though it does not directly observe q).[13] Then the updated belief about q would be ~N ($q'_{t|t-1}, \sigma_q^{2\prime}$),

[12] See Sims (2002) for a general set of restrictions for the existence and uniqueness of the solution. The simulation exercise in a later section—based on parameters similar to those estimated with the Mexican data—the existence of a non-explosive solution and its uniqueness is guaranteed.

[13] This assumption enables us to withdraw from dealing with time-varying volatilities in observation noises. See Milani (2007b) and references therein for learning with time-varying volatility.

where

$$q'_{t|t-1} = \frac{\frac{q_{t|t-1}}{\sigma_q^2} + \frac{\frac{i_t - gx_t}{E_t^{PS}\pi_{t+1}}}{q^2\sigma_v^2}}{\frac{1}{\sigma_q^2} + \frac{1}{q^2\sigma_v^2}}$$

and

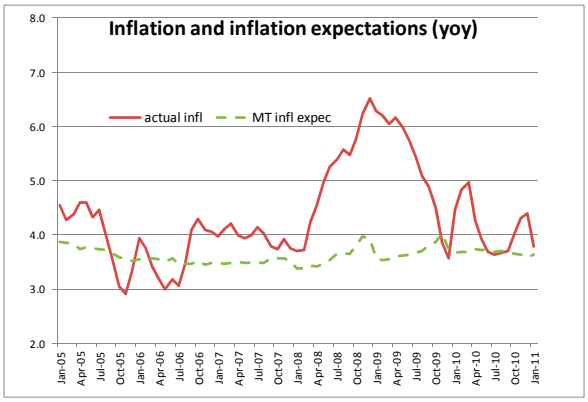
$$\sigma_q^{2\prime} = \left(\frac{1}{\sigma_q^2} + \frac{1}{q^2\sigma_v^2}\right)^{-1}$$

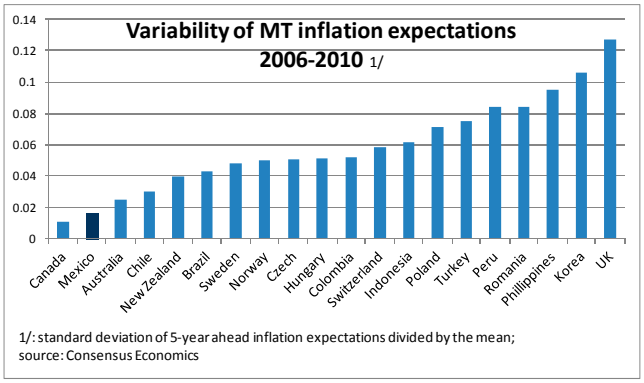
Before turning to estimation, it is worthwhile to note that in contrast to perpetual learning framework where the private sector only knows the model's structure but not any of its parameters, here we relax the assumption and allow it to be well-informed about the demand and supply equations and need to only learn about a parameter of the policy rule. This not only highlights the importance of policy communication, but also represents only a relatively small deviation from the benchmark full information models.

III. Data and Estimation

Mexico's Inflation Regime

Mexico's monetary policy regime has undergone significant evolution in the last two decades, with the adoption of an inflation targeting (IT) framework in the early 2000s representing a key milestone. In the aftermath of the 1994/5 Tequila crisis, Banxico switched from exchange rate targeting with a crawling band to monetary aggregate targeting. A brief period of disinflation notwithstanding, the monetary targeting regime proved ineffective in stabilizing inflation and inflation expectations in a sustained manner. It was only under the IT regime, along with the support of prudent fiscal policies, that Banxio succeeded in controlling inflation, bringing it down from 19 percent in 1999 to below 4 percent in 2003 and maintaining it close to the 3 percent target thereafter. Reflecting the gain of Banxico's credibility in delivering price stability, the price formation process in Mexico has also become much less persistent under the IT regime (e.g., Chiquiar et al., 2010), and medium-term inflation expectations have been very well-anchored—albeit somewhat above the target—despite the fluctuations in headline inflation. Moreover, Capistrán and Ramos-Francia (2010) show that the dispersion across analysts' inflation forecasts is reduced by having an IT framework in place.





In an effort to further strengthen the monetary policy regime, Banxico has recently taken important measures to enhance its strategy of communicating its assessment of the economic outlook, bringing it well in line with the international best practice. In particular: (i) Banxico started in 2011 publishing the minutes of its policy meeting, which include detailed analyses by Banxico staff on the global and domestic economies, and also extensively cover discussions amongst board members, presenting the nuances behind each policy decision and helping the private sector better understand the importance of various factors shaping the board's views; (ii) its quantitative assessment has increased in granularity, using fan charts that show baseline projections and the balance of risks; and (iii) there has been an increase in the number of public speeches and presentations by Banxico authorities, expanding communications beyond the formal channels.[14]

[14] Some central banks even opt to publish numerical projections of the interest rate path (e.g., Czech Republic, New Zealand, Norway). However, there is not yet a consensus on the benefits of such a practice (see, e.g., Mishkin, 2004; Andersson and Hofmann, 2009).

Communication Strategy of Selected Central Banks

Countries	Publication of Policy Meeting Minutes	Publication of Monetary Policy Reports	Explicit Interest Rate Assumption for Macro Forecasts
Mexico	Y	Quarterly	N
Brazil	Y	Quarterly	Y
Chile	Y	Quarterly	Y
Colombia	Y	Quarterly	N
Peru	N	3 per Year	N
Australia	Y	Quarterly	Y
Canada	N	Quarterly	N
Czech Republic	Y	Quarterly	Y
Iceland	Y	Quarterly	Y
Israel	Y	Semi-annual	Y
New Zealand	N	Quarterly	Y
Norway	N	3 per Year	Y
Sweden	Y	3 per Year	Y
U.K.	Y	Quarterly	Y
U.S.	Y	Semi-annual	N
ECB	N	Quarterly (forecasts)	Y
Switzerland	N	Quarterly	Y

Sources: National authorities; BIS (2009); Roger and Stone (2005); Tuladhar (2005); Gredig et al (2007).

Data for Mexico

The Mexican data we use for the estimation are time series of the macroeconomic variables involved in the model at quarterly frequency, taken mainly from Haver Analytics. The sample is from 2001: Q1 to 2010: Q1. The effective sample size is accordingly adjusted when leads or lags of variables are used in an estimation.

Variables are generally measured in standard ways. Inflation π_t is the percent quarter-on-quarter variation of the headline consumer price index which is seasonally adjusted.[15] Nominal short-term interest rate i_t is taken as the period-average of overnight interbank interest rate in percentage points.[16] In line with the New Keynesian literature, the output gap,

[15] Note that inflation is not converted into annual rate.

[16] This series from the original data is represented in annual rate, and is transformed into quarterly rate.

x, is measured by the real marginal cost of production, which is proxied for by the unit labor cost index for the manufacturing industry.[17] This series is seasonally adjusted and deviations from the trend are obtained by the Hodrick-Prescott filter with the standard parameters.

Estimation Results

To estimate the simple monetary model for Mexico, we use actual future outturns to proxy for expectations, but utilize GMM methodology to address the associated potential endogeneity.[18] The results point to an economic system with a significant forward-looking component and an interest rate reaction function that is very responsive to inflation. In particular, the estimates suggest that in both the pricing and production decisions, the private agents appear to be very forward looking, with their expectations of future economic developments featuring heavily in their current behaviors. Meanwhile, short-term interest rates seem to react strongly to inflation developments.[19]

$$(1)\ \pi_t = \lambda x_t + \vartheta_F E_t^{PS}\pi_{t+1} + \vartheta_B \pi_{t-1} + w_t^{\pi}$$
$$\text{where } \lambda = 0.03;\ \vartheta_F = 0.7;\ \vartheta_B = 0.2; \sigma^2(w_t^{\pi}) = 0.2$$

$$(2)\ x_t = \alpha_F E_t^{PS} x_{t+1} + \alpha_B x_{t-1} + \chi\left(i_t - E_t^{PS}\pi_{t+1}\right) + w_t^{x}$$
$$\text{where } \alpha_F = 0.5;\ \alpha_B = 0.4;\ \chi = -1.4; \sigma^2(w_t^{x}) = 3.9$$

$$(6)\ i_t = g x_t + q E_t^{PS}\pi_{t+1} + q v_t$$
$$\text{where } g = 0.1;\ q = 3.3;\ q^2\sigma^2(v_t) = 1.7$$

[17] See, e.g., Ramos-Francia and Torres (2006).

[18] For estimation of (1) and (2), the instruments include 3 lags of inflation, interest rate, and the output deviation from trend, and 2 lags of real marginal cost. For estimation of (6), the instrument set is the same but without lags of real marginal cost.

[19] Including the exchange rate in the estimations does not meaningfully improve the fit of the Phillips and IS curves, although the exchange rate effect may have been more prominent in the post-global crisis period. Our estimate of *q* is similar to OECD (2011) and Moura and Carvalho (2010), which include lagged interest rate in their estimations of the policy reaction function for Mexico.

IV. SIMULATIONS OF STYLIZED SCENARIOS

The section turns to several stylized scenarios to quantitatively study the potential role of information asymmetry in affecting inflation and policy dynamics, illustratively based on parameters similar to what we obtain from estimating a simple reduced-form monetary framework for Mexico. As Section II discusses, two aspects of information asymmetry between the central bank and the private sector—namely, regarding (i) the central bank's policy reaction function; and (ii) the central bank's assessment of the economic—may combine to give rise to unfavorable economic outcomes. Good communications by the central bank clearly explaining the basis for its decisions could mitigate the suboptimality considerably.

Calibration

To perform some illustrative simulations of the benefits of enhanced communications, this section uses estimates of parameters for Mexico. In particular, the IS curve, and the interest rate reaction function are as estimated in section III. However, for the Phillips curve, to be in line with the common findings for Mexico and other countries,[20] we adjust the weights on the forward- and backward-looking components to be 0.6 and 0.4, respectively.

In addition, to gain a perspective on the private sector's perception of interest rate policy, we estimate a policy reaction function using survey data on inflation expectations rather than the true future inflation outturns.[21] [22] Two parameters from this estimation are useful to parameterize the process of the private sector's learning about q in the policy reaction function. One is the variance of the estimated q (i.e., $\sigma^2(\hat{q})$), which helps us quantify how confident the PS is regarding their existing perception of the CB's responsiveness. The other is the variance of the estimation's error terms (i.e., $q^2\sigma^2(v_t)$), which can be interpreted as a measure of the randomness of the difference between the CB's and the private sector's assessments of the inflation outlook. However, it is assumed in the simulations that the private sector always starts with an initial prior about q at the "true" estimate that we obtain in section III (i.e., the private sector's prior about q is always assumed to start at 3.3).[23]

---

[20] In particular, the weight on the backward-looking component of the New Keynesian Phillips curve in our estimation seems low compared to other studies on Mexico and other countries. For example, see Gali, et al. (2001), Benigno and Lopez-Salido (2002) and Gagnon and Khan (2004), Cespeds, et al. (2005), and Ramos-Francia and Torres (2006).

[21] The one quarter-ahead inflation expectations are computed from Banxico's survey data on 12 month-ahead inflation expectations, under the simplifying assumption that the latter is geometrically accumulated from the former at a constant rate.

[22] A caveat to using the survey data is such information is conditional upon the individual analysts' own interest rate expectations, which are not necessarily the same as the "model-consistent" interest rates.

[23] In our simple analytical framework with unchanged policy reaction function, repeated learning over a long period of time implies that the distribution of the private sector's prior belief about q would converge around the

(continued…)

The re-estimated policy reaction function based on survey data on the PS's inflation expectations:

$$(6') \; i_t = gx_t + \hat{q}E_t^{PS}\pi_{t+1} + qv_t$$

$$\text{where } g = 0.1;\ \hat{q} = 1.6;\ \sigma^2(\hat{q}) = 0.6; q^2\sigma^2(v_t) = 0.1$$

Notably, the "q" in the re-estimated version is only about half the size of the estimate from the regression based on actual future inflation outturns, while the estimate on the coefficient on the unit labor cost is close to the earlier version.

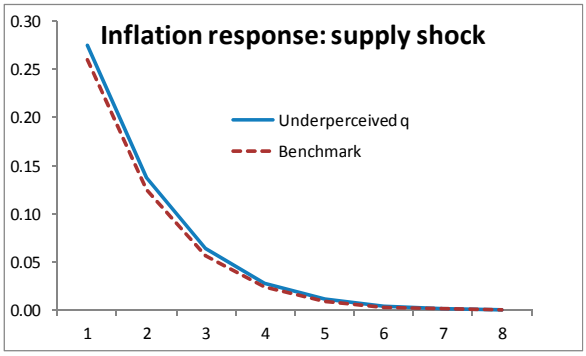
The Effect of Uncertainty About "q"

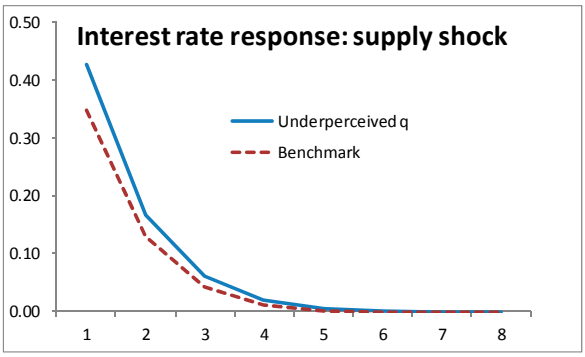
In a simple system such as the one we estimated before, monetary policy decisions influences inflation through affecting the current output and also through people's expectations about how interest rates would react in the future. Via this second channel, perception of the monetary reaction function—in addition to the knowledge of the current level of interest rate—therefore matters for inflation. For instance, if people believe that future interest rates would not react strongly to the propagation of any inflation shocks that occur today, their expectations of future inflation would be affected accordingly, which would in turn feed into their pricing behaviors today.

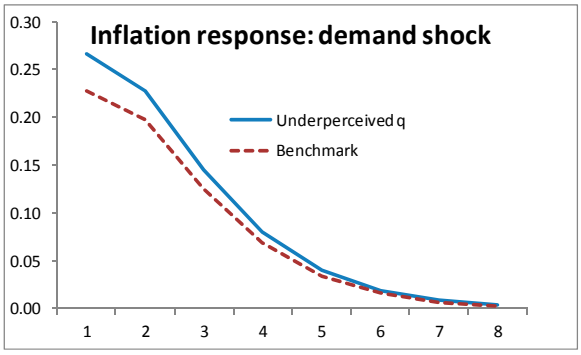
Indeed, a perception of q that is lower than the true q would yield a higher inflation than otherwise. As an illustration, the following simulation—with the parameters calibrated as discussed above—assumes that the value of q estimated in the Taylor rule based on survey-based data is the private sector's perception of central bank's true q. Responding to an one-off unanticipated shock, the inflation outcome would be less favorable than in the case where the perceived q is the same (and as high as) the true q ("Benchmark").[24] Accordingly, the central bank would have to adjust the interest rates by a greater amount in response to the bigger impact on inflation.

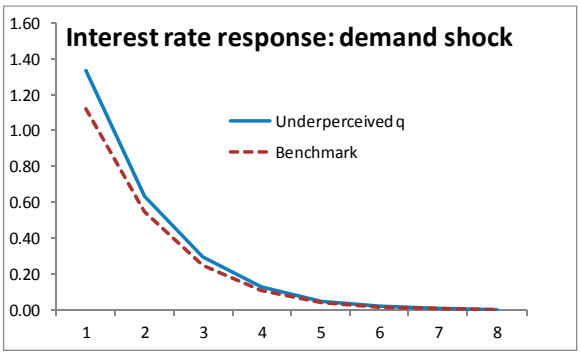
"true" value with decreasing variance. In practice, however, the policy reaction function may change from time to time (e.g., depending on the policy board's composition) and hence even repeated learning cannot guarantee a convergence of belief in the long run.

[24] The demand and supply shocks here are calibrated so as to generate a 0.275 percentage point deviation in inflation from the steady state in the first period.









Note that the unfavorable outcomes shown above arise purely from the first source of information imperfection discussed above (uncertainty about and in fact the private sector's underperception of q). However, there is no asymmetry assumed in the assessment of economic outlook—the above charts show the effect of a 1-period shock anticipated by neither the private sector nor the central bank. In fact, a lack of clarity on the part of the private sector about the central bank's assessment of the outlook or the factors driving its interest rate decisions may endogeneously lead to a lower perceived q and amplify the impact of shocks.

Imperfect Information Regarding the Central Bank's Economic Assessment

We now turn to cases where the central bank's view on the outlook (specifically, its belief about the characteristics of any incoming shocks) is unknown to the private sector, who takes their own view as a proxy for the central bank's when forming expectations about the future path of interest rate decisions. As before, the private sector is also uncertain about the central bank's true q. But to focus on the effect of unknown central bank outlook, in the following we abandon the previous ad hoc assumption about underperceived q. We suppose instead that the private sector's perceived q is initially the same as the true q, but they would update their belief depending on the subsequent developments in a Bayesian fashion.

We highlight the uncertainties concerning three main aspects of the shocks' characteristics: (A) the timing of the shock; (B) the nature (supply vs. demand) of the shock; and (C) the duration, or persistence, of the shock.

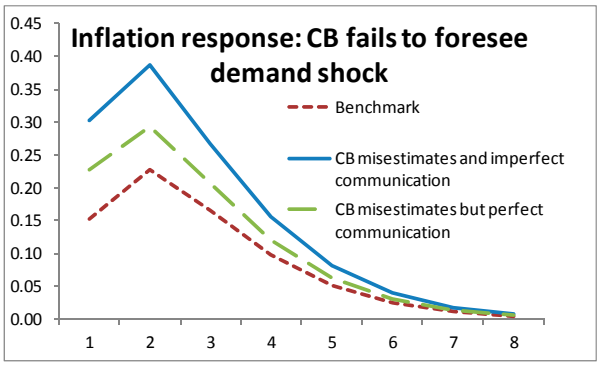
(A) Timing of shocks

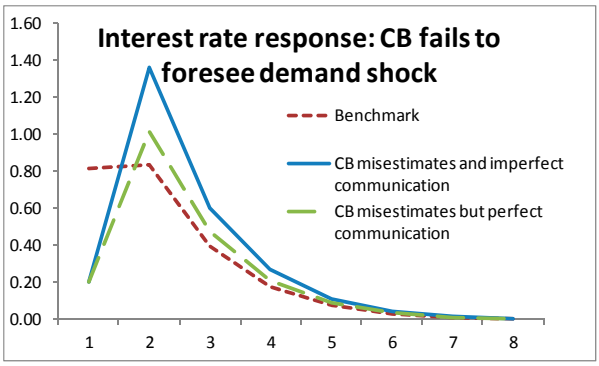
Policy discussion and market commentaries often center on outlining the baseline as well as risks. While there may be a broad consensus on type of challenges and opportunities facing the economy, there is usually much less agreement on the likelihood and timing of the risks materializing.[25] How would the private sector's lack of clear knowledge about the central bank's thinking on this issue affect the inflation and policy outturns in our setting?

Assume that the private sector correctly envisages that a demand shock will materialize in the next period (t=2); but the central bank inaccurately believes that no shocks will arrive on the horizon and realizes its mistake only when the shock hits in t=2.

Compared to the benchmark (where both the private sector and the central bank are correct in predicting the shock, and there is no information imperfection), the central bank's inaccuracy—along with insufficient communication to the private sector about its economic assessment—drives inflation to about twice as high. The intuition is simple. Not anticipating the demand shock, the central bank is overly dovish and lets the interest rate stay at a low level in t=1. Using their own outlook assessment as a proxy for the central bank's (in the absence of a clear rationalization of its policy decisions by the central bank), the private sector interprets the low interest rate in t=1 as a sign that the central bank is not very responsive to the inflation surge expected in t=2.

Technically, the observation of low interest rate—through Bayesian updating—lowers the private sector's perception of q. This in turn leads them to expect a more accommodative monetary stance in t=2, and hence a higher inflation expectation for t=2, which feeds back into a higher inflation in t=1 in a forward-looking setting.





[25] For example, there may be a diverse view on the strength and timing of passthrough from a previous exchange rate adjustment, or on whether an asset price boom would lead to greater domestic demand, etc.

For the interest rate, after deciding on a low interest rate in t=1, the central bank has to catch up afterward to contain the inflationary pressure in t=2 after realizing that it had failed to anticipate the incoming shock. Interest rate falls slowly in t=3 and beyond as the large inflation impact of the shock dissipates only gradually.

Role of communication

Clear communication by the central bank to the private sector about its thinking (or the basis for its interest rate decision), however, would ameliorate the unfavorable outturns. In Bayesian terminology, with a high level of communication about the reasons underlying its decisions, the central bank could allow the private sector to efficiently extract from the interest rate observation a precise signal about its inflation responsiveness. In other words, through good communication, the central bank can effectively anchor the private sector's belief about its intolerance toward inflation deviation. As discussed previously, our framework already assumes well-anchored medium-term inflation expectations. The emphasis here is on the anchoring of the belief of how fast (rather than whether) the central bank would bring inflation back to the target

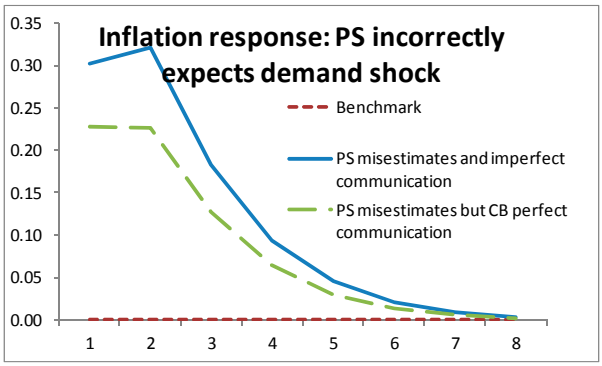
The green dashed line in the charts above depict the outcome for the example when the central bank fails to foresee the demand shock (as before) but it has perfectly communicated what its outlook assessment. In this case, although observing the low interest rates in t=1, the private sector understands that the central bank's decision is driven by its benign inflation outlook rather than its lack of responsiveness to inflation deviation. While inflation at t=1 is still higher than the benchmark (directly due to a lower-than-benchmark interest rate), it is significantly below the imperfect communication case—knowing that the central bank is in fact responsive to inflation threats, the private sector expects the central bank to act strongly in t=2 once the demand shock hits; and this expectation leads to a lower inflation expectation for t=2 and hence a more contained inflation at t=1. Looking at the chart, one can quantify the relative value of transparency in terms of the degree of inflation deviation from the steady state: the distance between the blue line and the green dashed line represents the gains from full transparency when there are mistakes in outlook assessment[26], compared to the distance between the green dashed line and the red dotted line which represents the costs of mistakes (in this case the central bank's). The distance between the red dotted line and the horizontal axis represents the effect of the shock in a strict absence of any forecast inaccuracies or information imperfection.

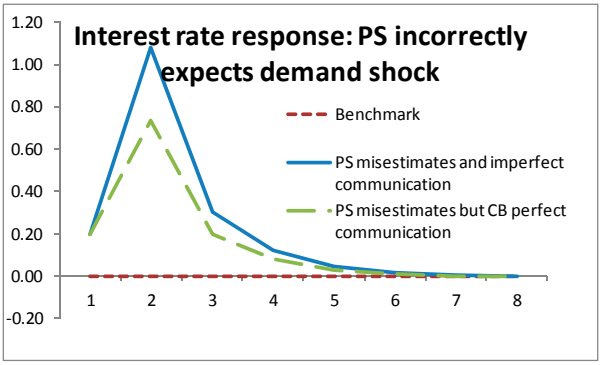
And with the t=2 inflation outturn less unfavorable, the central bank does not need to raise rates as sharply as otherwise. While not modeled in our stylized framework, a smoother—and more importantly a better anticipated—interest rate adjustment should be desirable for

[26] Note that if there are no mistakes by either the central bank or the private sector in assessing the outlook, transparency creates no value in our case (the blue line would coincide with the benchmark case), as we assume that the initial perceived q is the same as the true q.

financial markets.[27] This case underscores the importance of the central bank being clear and transparent about its policy decision considerations even if (indeed, particularly if) those considerations turn out to be inaccurate.

Similarly, the benefit of enhanced central bank communication also shows up even in cases in which only the private sector is inaccurate in their outlook assessment whereas the central bank is correct. The benefit arises here not because the central bank could influence the private sector into adopting the correct assessment (we assume against such a possibility), but again because of the "anchoring" effect akin to what is discussed above—a clear central bank communication allows the private sector to precisely gauge the central bank's responsiveness to inflation and hence promotes a more favorable price formation process by the private sector.





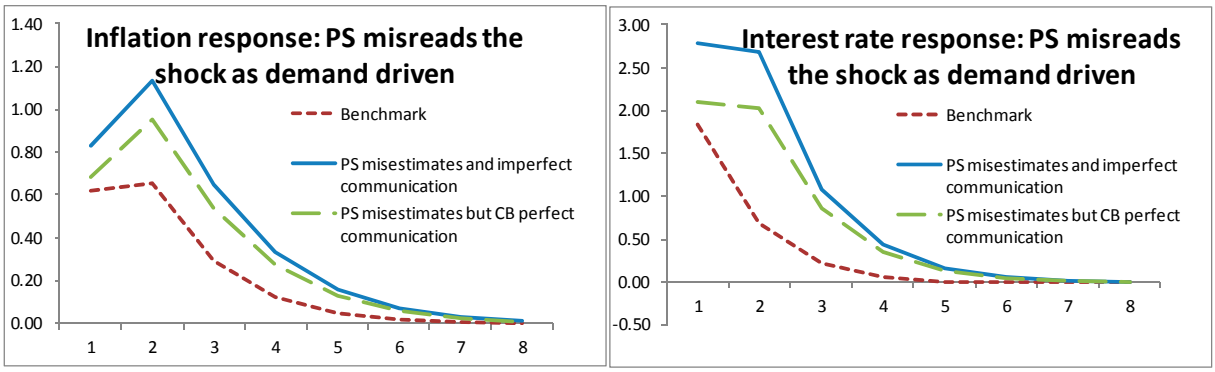
(B) Nature of shocks

While inflation outcome is typically well measured, real-time output data are usually much noisier. Moreover, output gap—the relevant measure for the monetary policymakers—depends on the observed potential output, complicating even further the diagnosis of the outlook for the economy. In particular, difficulty sometimes arises in attributing the reason of an observed rise in inflation (or inflationary pressure)—whether it is a direct result of a supply (inflation) shock, or driven by an underlying demand (or output gap) shock.

As in the case where the timing of the shocks is uncertain, strong central bank transparency could help reduce the inefficiency associated with any mistakes in the assessment of the nature of the shocks either by the central bank or the private sector.

[27] Many central bank officials have expressed a preference for a slow policy adjustment to avoid surprising and roiling the markets. For a different reason why inertial interest rate path is optimal, see Woodford (2002).

One example is depicted as follows: suppose the private sector mistakenly interprets the shock causing an increase in inflation as demand driven, while the central bank (correctly) believes that the shock is supply driven. Further, assume that the shock is persistent and lasts for two periods in t=1, 2 (and both the central bank and the private sector correctly anticipate that), and that the private sector realizes the true nature of the shock only in t=2. In this case, the private sector expects the central bank to more aggressively raise interest rates in t=1 as demand shocks would move both of the key determinants of the policy rule in the same direction. On the other hand, however, given that the central bank believes that the inflationary pressure is driven by supply shock while the underlying demand factors are not directly affected, the central bank would in fact react more mildly with a less prounced increase in interest rates. Following a similar chain of logic as discussed in the previous subsection, the private sector would then take the observation of only a modest interest rate hike as a signal of relative dovishness on the part of the central bank, thus pushing up their inflation expectations for t=2 as well as inflation in t=1. Mirroring the steep increase in inflation, the policy rates need to be raised by much more than in the benchmark case (where the private sector also correctly interprets the shock as supply driven).



However, good communication by the central bank about the reasons why it decides against raising the interest rates by more than it actually does would, as previously highlighted, help entrench a belief of strong reaction to inflation deviation (ceteris paribus) by allowing the private sector to do a more efficient Bayesian learning about the degree of its inflation tolerance. This in turn would yield a less dramatic rise in inflation and a smaller adjustment need for the policy rates.

(C) Persistence of shocks

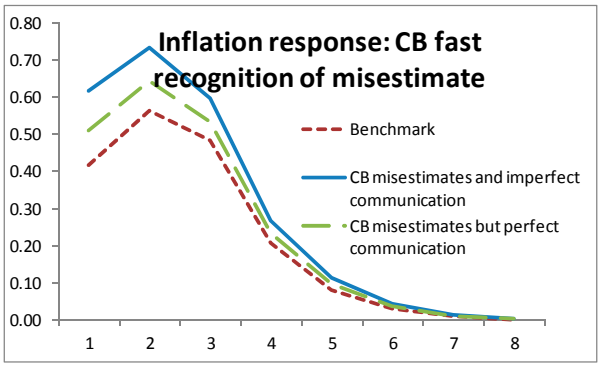
Another key difficulty in economic projections involves an assessment of the duration of the shocks (or how long is the sequence of incoming shocks). A recent case in point is the experience of the 2007/8 commodity price shocks, an episode during which there were debates around the world on how persistent those shocks were likely to be, how likely they

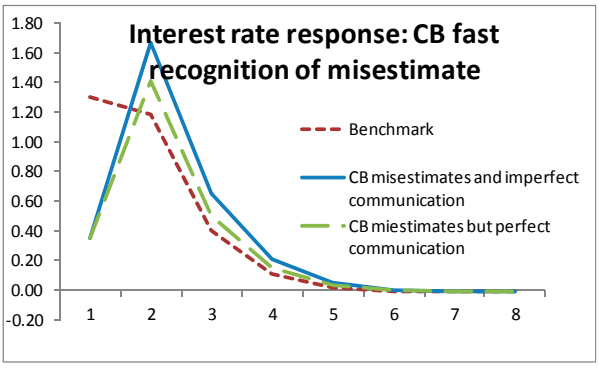
would lead to an inflation spiral, and what the optimal monetary policy response should be in those circumstances.[28, 29]

Two examples are constructed in the following to illustrate the benefits of central bank transparency in the context of uncertainty about the duration of a supply shock, and how those benefits increase with a greater judgment asymmetry between the private sector and the central bank (or a slower realization of misjudgment). In both examples, the true duration of supply shocks is 3-period.[30]

Fast recognition of misestimate

In the first case, the central bank initially misestimates the supply shock is transitory and lasts only 1 period, but realizes its mistake in t=2 and expects then the shock would last till t=3. In contrast, the private sector always correctly expects that the supply shocks would persist for 3 periods.





As before, the suboptimal outcome reflects the costs of the central bank's misjudgment about the shock duration, as well as a "de-anchoring" of the private sector's perception of the central bank's inflation intolerance due to imperfect information. In particular, the excessively low interest rate pursued by the central bank in t=1 (driven by its underestimation of the shock duration) leads the private sector to doubt its responsiveness to inflation in t=2

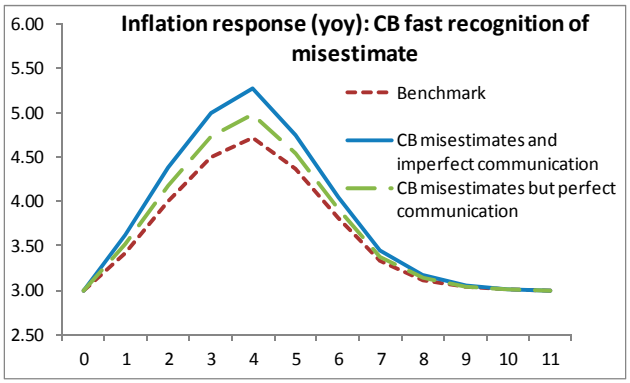
[28] For instance, some suggested that concerns about spillovers to wages and core inflation called for a tightening in monetary policy, while others who thought the commodity price shocks were transient and weighed on demand and activity argued against that.

[29] A spillover to the core inflation could be broadly interpreted as a supply shock of a very long duration. In other words, uncertainty about the likelihood of commodity prices contemplating the core inflation can be viewed as an uncertainty about the duration of the supply shock in our current setting.

[30] In our setting, it means a supply shock is applied to each of the first three periods.

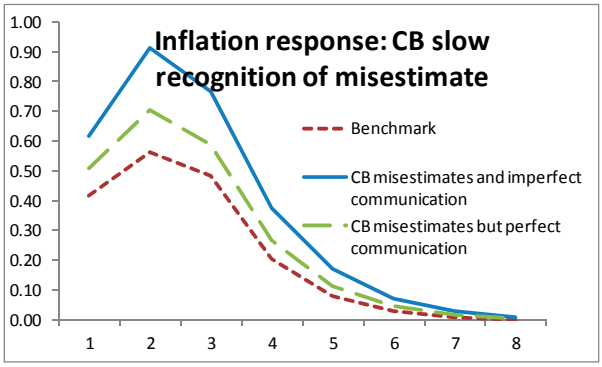
and hence expect a higher inflation in t=2. As the central bank realizes in t=2 that the shock would last till t=3, and in dealing with the high inflation, it raises rates rapidly. A perfect communication by the central bank about the reasons for its t=1 decision, however, would have allowed the private sector to understand the policy function and led them to expect a strong interest rate response in t=2 to inflation. In sum, having better communication in this example would enable the central bank to more effectively contain inflation while also reducing the need to tighten the monetary policy stance in the face of adverse supply shocks.

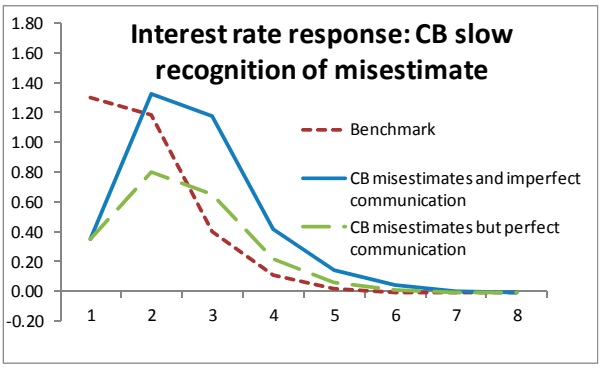
Expressing the inflation outturns as a year-on-year measure and assuming a 3 percent steady-state inflation, the imperfect communication scenario in this example would yield a peak inflation of 5.3 percent, while the perfect communication would have reduced the peak inflation by 0.3 points to 5.0 percent. Similarly, the imperfect communication scenario implies a peak interest rate of 1.7 percent, 0.3 points (or 1.2 points in annualized terms) higher than that in the perfect communication scenario (from the chart above).



Slow correction of misestimate

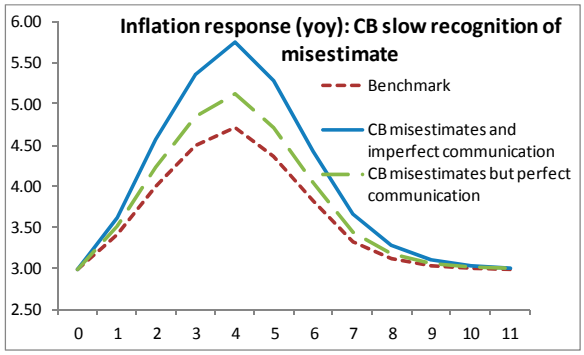
The importance of communications, however, becomes much greater when there is only a slow central bank recognition of the true duration of the supply shock (perhaps due to an unusually high degree of uncertainty surrounding the outlook). In this second example, the central bank misbelieves that the shock is transitory (lasting no longer than one period). Specifically, in all the three periods, while observing the contemporaneous shock, the central bank (inaccurately) expects no further shocks in the future.





As expected, the inflation outcome is much less favorable in this case, as the persistent underestimation of the shock duration by the central bank results in consecutive periods of excessively low interest rate decisions, which significantly lowers the private sector's belief about the central bank's responsiveness to inflation. The perception of a dovish central bank generates a higher expectation for future inflation, compounding the contemporaneous inflationary pressure. And precisely because of the constant misestimates, there are potentially greater gains in this case from transparency.

Expressed in year-on-year terms the benefit of perfect communication would be a 0.7 point reduction in inflation, yielding a peak inflation of 5.1 percent, compared to the 5.8 percent in the case of imperfect communication. Moreover, the interest rate for the imperfect communication case peaks at a higher level and remains elevated for longer than that for the perfect communication scenario (chart above).



V. CONCLUDING REMARKS

This paper builds and estimates a New Keynesian model embedding the realistic feature of asymmetric economic assessment between the central bank and the private sector. We show that imperfect central bank communication about its assessment (which serves as the basis of its policy decisions) could compound the inefficiency arising from the asymmetric assessment, undermining the private sector's ability to learn the central bank's policy rule.

We then estimate a simple monetary model (the New Keynesian Phillips curve, IS curve, and reduced-form monetary policy rule) to fit the Mexican economy, extending earlier work by e.g., Ramos-Francia and Torres (2006). Based on parameters similar to those estimates, we then simulate stylized scenarios involving uncertainty about different properties of the shocks (i.e., their timing, nature, and persistence) and illustrate how better central bank communication could give rise to less volatile inflation and interest rate dynamics, even when the central bank's assessment turns out to be inaccurate. The results are also in line with the existing empirical literature linking greater central bank transparency to more stable (though not less persistent) inflation. In terms of policy, the exercise shows how more effective communication can promote more favorable output-inflation tradeoffs and in principle afford the authorities with a greater degree of policy flexibility, which is likely to be particularly valuable in times of heightened uncertainty about the economic outlook.

REFERENCES

Alichi, Ali, H. Chen, K. Clinton, C. Freedman, M. Johnson, O. Kamenik, T. Kisinbay, and D. Laxton, 2009, "Inflation Targeting Under Imperfect Policy Credibility" *IMF Working Paper 09/94* (Washington, DC: International Monetary Fund).

Andersson, Magnus, and B. Hofmann, 2009, Gauging the Effectiveness of Quantitative Forward Guidance: Evidence from Three Inflation Targeters. *ECB Working Paper* No. 1098.

Andersson, Malin, H. Dillen, and P. Sellin, 2006, Monetary Policy Signaling and Movements in the Term Structure of Interest Rates. *Journal of Monetary Economics*, 53(8): 1815–55.

Aoki, Kosuke, and T. Kimura, 2008, Central Bank's Two-Way Communication with the Public and Inflation Dynamics. Working Paper, Department of Economics, LSE.

Bank for International Settlements, 2009, Communication of Monetary Policy Decisions by Central Banks: What is Revealed and Why. *BIS Papers No 47*.

Banternghansa, Chanont and M. McCracken, 2009, Forecast Disagreement among FOMC Members. Working Paper 2009–59, Federal Reserve Bank of St. Louis.

Batini, Nicoletta, and A. Haldane, 1999, Forward-Looking Rules for Monetary Policy. in Taylor, John, ed. *Monetary Policy Rules*. Chicago, IL: The University of Chicago Press.

Benati, Luca, 2008, Investigating Inflation Persistence across Monetary Regimes. *Quarterly Journal of Economics*, 123(3): 1005–60.

Benigno, Pierpaolo, and D. Lopez-Salido, 2006, Inflation Persistence and Optimal Monetary Policy in the Euro Area. *Journal of Money, Credit and Banking*, 38(3): 587–614.

Berardi, Michele, 2009. Monetary Policy with Heterogeneous and Misspecified Expectations. *Journal of Money, Credit and Banking*, 41(1): 79–100.

Bernanke, Ben, and F. Mishkin, 1997, Inflation Targeting: A New Framework for Monetary Policy? *Journal of Economic Perspectives*, 11(2): 97–116.

_____, and M. Woodford, 1997, Inflation Forecasts and Monetary Policy. *Journal of Money, Credit and Banking*, 29(4): 653–84.

_____, and M. Woodford, 2005, ed. *The Inflation-Targeting Debate*. Chicago, IL: The University of Chicago Press.

Blinder, Alan, 2000, Central-Bank Credibility: Why Do We Care? How Do We Build It? *American Economic Review*, 90(5): 1421–31.

_____, M. Ehrmann, M. Fratzscher, J. De Haan, and D. Jansen, 2008, Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence. *Journal of Economic Literature*, 46(4): 910–45.

Branch, William, and B. McGough, 2009, A New Keynesian Model with Heterogeneous Expectations. *Journal of Economic Dynamics and Control*, 33(5): 1036–51.

_____, and G. Evans, 2010, Monetary Policy and Heterogeneous Expectations. Working Paper, Department of Economics, University of California, Irvine.

Brock, William, and C. Hommes, 1997, A Rational Route to Randomness. *Econometrica*, 65(5): 1059–96.

_____, and C. Hommes, 1998, Heterogeneous Beliefs and Routes to Chaos in a Simple Asset Pricing Model. *Journal of Economic Dynamics and Control*, 22(8–9): 1235–74.

_____, S. Durlauf, and K. West, 2007, Model Uncertainty and Policy Evaluation: Some Theory and Empirics. *Journal of Econometrics*, 136(2): 629–64.

Calvo, Guillermo, 1983. Staggered Prices in a Utility-maximizing Framework. *Journal of Monetary Economics*, 12(3): 383–98.

Capistrán, Carlos, and M. Ramos-Francia, 2010, Does Inflation Targeting Affect the Dispersion of Inflation Expectations? *Journal of Money, Credit and Banking*, 42(1): 113–134.

_____, and A. Timmermann, 2009, Disagreement and Biases in Inflation Expectations. *Journal of Money, Credit and Banking*, 41(2–3): 365–96.

Céspedes, Luis, M. Ochoa, and C. Soto, 2005, The New Keynesian Phillips Curve in an Emerging Market Economy: The Case of Chile. Working Papers 355, Central Bank of Chile.

Chiquiar, Daniel, A. Noriega, and M. Ramos-Francia, 2010. A Time Series Approach to Test a Change in Inflation Persistence: The Mexican Experience. *Applied Economics*.

Clarida, Richard, Jordi Gali, and Mark Gertler, 1998. Monetary Policy Rules in Practice: Some International Evidence. *European Economic Review*, 42(6): 1033–67.

_____, J. Gali, and M. Gertler, 1999. The Science of Monetary Policy: A New Keynesian Perspective. *Journal of Economic Literature*, 37(4): 1661–707.

Collard, Fabrice, and H. Dellas, 2004, The New Keynesian Model with Imperfect Information and Learning. IDEI Working Papers 273, Institut d'Économie Industrielle, Toulouse.

D'Amato, Jeffery, S. Morris, and Hyun Song Shin, 2002, Communication and Monetary Policy. *Oxford Review of Economic Policy*, 18(4): 495–503.

De Grauwe, Paul, 2010, Animal Spirits and Monetary Policy. *Economic Theory*, online first.

Dincer, Nergiz, and B. Eichengreen, 2007, Central Bank Transparency: Where, Why, and with What Effects? NBER Working Papers 13003.

_____, and B. Eichengreen, 2009, Central Bank Transparency: Causes, Consequences and Updates. NBER Working Papers 14791.

Ehrmann, Michael, and M. Fratzscher, 2009, Explaining Monetary Policy in Press Conferences. *International Journal of Central Banking*, 5(2): 42–84.

Erceg, Christopher, and A. Levin, 2003, Imperfect Credibility and Inflation Persistence. *Journal of Monetary Economics*, 50(4): 915–944.

Eusepi, Stefano, and B. Preston, 2010, Central Bank Communication and Expectations Stabilization. *American Economic Journal: Macroeconomics*, 2(3): 235–71.

Evans, George, and S. Honkapohja, 2001, *Learning and Expectations in Macroeconomics*. Princeton, NJ: Princeton University Press.

Faust, Jon, and L. Svensson, 2001, Transparency and Credibility: Monetary Policy with Unobservable Goals. *International Economic Review*, 42(2): 369–97.

Fracasso, Andrea, H. Genberg, and C. Wyplosz, 2003, *How do Central Banks Write? An Evaluation of Inflation Reports by Inflation Targeting Central Banks*. London, UK: Centre for Economic Policy Research.

Fujiwara, Ippei, 2005, Is the Central Bank's Publication of Economic Forecasts Influential? *Economics Letters*, 89(3): 255–61.

Gagnon, Edith, and H. Khan, 2005, New Phillips Curve under Alternative Production Technologies for Canada, the United States, and the Euro area. *European Economic Review*, 49(6): 1571–602.

Gali, Jordi, Mark Gertler, and D. Lopez-Salido, 2001, European Inflation Dynamics. *CEPR Discussion Papers 2684.*

Gaspar, Vitor, F. Smets, and D. Vestin, 2006, Adaptive Learning, Persistence, and Optimal Monetary Policy. *Journal of the European Economic Association*, 4(2–3): 376–85.

Giannoni, Marc, and M. Woodford, 2010, Optimal Target Criteria for Stabilization Policy, Working Paper, Department of Economics, Columbia University.

Gredig, Fabian, K. Schmidt-Hebbel, and R. Valdes, 2007, The Monetary Policy Horizon in Chile and Other Inflation Targeting Countries. *Central Bank of Chile Working Papers*.

King, Robert, Yang Lu, and E. Pastén, 2008, Managing Expectations. *Journal of Money, Credit and Banking*, 40(8): 1625–66.

Kohn, Donald, and B. Sack, 2004, Central Bank Talk: Does it Matter and Why? *Macroeconomics, Monetary Policy, and Financial Stability*, 175–206. Ottawa, Bank of Canada.

Mankiw, N. Gregory, R. Reis, and J. Wolfers, 2003, Disagreement about Inflation Expectations. *NBER Macroeconomics Annual 2003*, 18: 209–70.

McCallum, Bennet, 1988, Robustness Properties of a Rule for Monetary Policy. *Carnegie-Rochester Conference Series on Public Policy*, 29(1): 173–203.

Milani, Fabio, 2007a. Expectations, Learning and Macroeconomic Persistence. *Journal of Monetary Economics*, 54(7): 2065–82.

_____, 2007b. Learning and Time-Varying Macroeconomic Volatility. Working Paper, University of California-Irvine.

Minegishi, Makoto, and B. Cournède, 2009, The Role of Transparency in the Conduct of Monetary Policy. OECD Economics Department Working Papers 724.

Mishkin, Frederic, 2004, Can Central Bank Transparency Go Too Far? *NBER Working Paper* no. 10829.

Moura, Marcelo, and A. de Carvalho, 2010, What can Taylor Rules Say about Monetary Policy in Latin America? *Journal of Macroeconomics*, 32: 392–404.

Nunes, Ricardo, 2009, Learning the Inflation Target. *Macroeconomic Dynamics*, 13(02): 167–88.

OECD, 2011. OECD Economic Surveys: Mexico.

Orphanides, Athanasios, and J. Williams, 2002, Robust Monetary Policy Rules with Unknown Natural Rates. *Brookings Papers on Economic Activity*, 2 (2002): 63–118.

_____, and J. Williams, 2006, Inflation Targeting under Imperfect Knowledge. Working Papers 398, Central Bank of Chile.

_____, and J. Williams, 2007, Robust Monetary Policy with Imperfect Knowledge. *Journal of Monetary Economics*, 54(5): 1406–35.

Pesaran, M. Hashem, and M. Weale, 2006, Survey Expectations in Elliott, Graham, Clive Granger, and Allan Timmermann, ed. *Handbook of Economic Forecasting*, Elsevier.

Ramos-Francia, Manuel, and A. Torres García, 2005, Reducing Inflation Through Inflation Targeting: The Mexican Experience. Working Papers 2005–01, Banco de México.

_____, Manuel, and A. Torres García, 2006, Inflation Dynamics in Mexico: A Characterization Using the New Phillips Curve. Working Papers 2006–15, Banco de México.

Ravn, Morten, and H. Uhlig, 2002, On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations. *Review of Economics and Statistics*, 84(2): 371–5.

Roberts, John, 1995, New Keynesian Economics and the Phillips Curve. *Journal of Money, Credit and Banking*, 27(4): 975–84.

Roger, Scott, and M. Stone, 2005, On Target: The International Experience with Achieving Inflation Targets. *IMF Working Paper 05/163* (Washington, DC: International Monetary Fund).

Rozkrut, Marek, , K. Rybinski, L. Sztaba, and R. Szwaja, 2007, Quest for Central Bank Communication: Does it Pay to Be "Talkative"? *European Journal of Political Economy*, 23(1): 176–206.

Rudebusch, Glenn, and J. Williams, 2008, Revealing the Secrets of the Temple: The Value of Publishing Central Bank Interest Rate Projections. in Campbell, John, ed. *Asset Prices and Monetary Policy*, Chicago, IL: The University of Chicago Press.

Sargent, Thomas, 1999, *The Conquest of American Inflation*. Princeton, NJ: Princeton University Press.

Sims, Christopher, 2002, Solving Linear Rational Expectations Models. *Computational Economics*, 20 (1–2): 1–20.

Svensson, Lars, 1997, Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets. European Economic Review, 41(6): 1111–46.

_____, 1999, Inflation Targeting as a Monetary Policy Rule. Journal of Monetary Economics, 43(3): 607–54.

Taylor, John, 1993, Discretion versus Policy Rules in Practice: *Carnegie-Rochester Conference Series on Public Policy,* 39(1): 195–214.

_____, 1999, ed. *Monetary Policy Rules.* Chicago, IL: The University of Chicago Press.

Tuladhar, Anita. 2005, Governance Structures and Decision Making Roles in Inflation Targeting Central Banks. *IMF Working Paper 05/183* (Washington, DC: International Monetary Fund).

Walsh, Carl, 2010, *Monetary Theory and Policy*, Third Edition. Cambridge, MA: The MIT Press.

Woodford, Michael, 1999, Optimal Monetary Policy Inertia. Working Paper, Department of Economics, Columbia University.

_____, 2003, *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton, NJ: Princeton University Press.

_____, 2005, Central Bank Communication and Policy Effectiveness. Proceedings, Federal Reserve Bank of Kansas City, 399–474.