Inflation Reports: Insights or Gibberish?

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Abstract

We compare model-identified inflation factors with those reported by the central banks. We argue that a higher correlation between the model-identified and central bank-reported inflation factors indicates better quality of inflation (monetary policy) reports. Our reduced-form, new-Keynesian models capture the state of the world reasonably well and low correlations thus are not driven by poor model-identified estimates of inflation factors. We find that sophisticated inflation targeters have generally reported inflation factors similar to those model-identified by the country-specific models, while the reporting record of lite targeters has been mixed.

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I. INTRODUCTION

The literature suggests various approaches to evaluating the quality of inflation and monetary policy reports.[2] While some authors focus on the formal quality of the text, others measure the volume of information disclosed, or consistency with other communication tools. Nevertheless, none of the above approaches assess inflation reports' analytical power. In other words, these reports can be voluminous and nicely written and dovetailed with other communication, but they can be only gibberish that fails to affect public's expectations. Of course, measuring of the true state of the world is difficult and so is defining a corresponding benchmark for the analytical power of inflation reports.

This paper proposes a novel methodology to assess whether central bank communication corresponds to true state of the world or not. In our methodology, communication is represented by the forward-looking inflation reports in which the policymaker reports factors that are to affect inflation in the foreseeable future.[3] We start by collecting *reported inflation factors* identified in each document as relevant for the current vintage of the inflation forecast or projection.[4] To this end, we manually code inflation reports and transform the verbal inputs (contributing to either lower or higher inflation) into numerical variables (+1 or –1). We then aggregate the factors into three groups: demand, supply and exchange rate factors. In this step we work with real-time data, that is, information available to the policymaker at the time of the issuance of the inflation report.

Second, we estimate *model-identified inflation factors* using a reduced-form, calibrated country-specific new-Keynesian model akin to those used by most central banks (see, for example, Berg, Karam, and Laxton, 2006). The model-identified factors are defined so that they correspond to the reported inflation factors collected in the first step from inflation reports, reflecting moreover revised ex post data and thus representing the "state of the world." We first take the model to the data, and estimate economic shocks based on the method of the Kalman filtration, quantifying the exact, time-varying effects of different shocks on inflation. The observed inflation rate is then decomposed into the inflation factors using inflation accounting in the spirit of Smets and Wouters (2007). In this process we also identify the autonomous impact of monetary policy as inflation unexplained by the supply, demand, and exchange rate (and other foreign) shocks is residually attributable to the monetary policy shocks. The monetary policy shocks measure the extent to which the monetary stance was too loose/tight given the state of the world and the inflation target.

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[2] Although the names of the various monetary policy documents differ across countries, for simplicity, we call them all "inflation reports" in this paper. See Annex I for names of these documents for our sample countries.

[3] "The policymaker" in most central banks is a collective body with heterogeneous views and we use the singular voice for simplicity only.

[4] While some central banks identify their predictions of inflation as forecasts, based on an economic model with a policy reaction function, others identify these predictions as projections, conditional on explicit assumptions vis-à-vis the interest rate, see Annex I.

Providing the model-identified inflation factors reflect the true state of the world, a reasonable assumption in our view, a significant positive correlation between the former and latter inflation factors is a measure of quality of inflation reports. We do not know, of course, with what leads the forward-looking reports identify each inflation factor and thus compute the correlation coefficients with several leads, comparing the current-period model-identified inflation factors with reported inflation factors leading by 0, 2, 4, and 6 quarters. Reports that have ex ante identified inflation factors that were ex post corroborated by model-based inflation accounting are likely to anchor the public's inflation expectations well (Bernanke, and Woodford, 1997). In contrast, either insignificant or negative correlations between these two sets of factors suggest that the analytical power of the reports is weak and that the policymaker reports gibberish, with potentially dire consequences for the public's expectations. The outcome of our computations is of course limited by the explanatory power of the new-Keynesian model that we use to identify the ex-post inflation factors. Hypothetically, as insignificant correlation between the model-identified and reported inflation factors could also be an outcome of the model failing to capture the state of the world that the inflation reports correctly anticipated. We find this explanation improbable, especially given that the forecasting performance of our country-specific models is quite satisfactory.

One could challenge also the assumption that the inflation reports correctly capture the economic views of the policymaker, arguing that the policymaker has either an unpublicized objective, intentionally doctoring the message, or acts strategically vis-à-vis the public. Our view is that a doctored inflation report is as bad as, if not worse than, a bona fide wrong analysis of inflation, because it violates the key underpinning of efficient monetary policy communication: transparency. Poor analysis and an unpublicized objective both fail to anchor the public's expectations.

We test our methodology on a sample of industrial and emerging market country central banks, for simplicity calling their policy objectives "inflation targets" (Annex I). Regarding the former, Sweden is one of the original, full-fledged inflation targeters—the Riksbank introduced inflation targeting in 1993. The European Central Bank is not formally an inflation targeter—it formally maintains a price stability objective in the context of a two-pillar strategy—however, it communicates in a manner comparable to the inflation targeters. Regarding the latter, Banco Central de Chile, the Czech National Bank and the Bank of Thailand have been classified as full-fledged inflation targeters, while the National Bank of Hungary and National Bank of Poland have been classified as "lite" inflation targeters (Carare and Stone, 2006). Lite implies that the inflation target was not as the foremost policy objective and the regime has served mostly as a disinflation device.

Despite different institutional frameworks inflation performance was rather similar in our sample countries, deviating from the targets announced by all central banks and mostly undershooting them (Figure 1). Interestingly, all central banks projected inflation to be close to the target (or the mid-point of the target range) at the end of the forecast period. Detailed discussion of inflation targets, forecasts, and outturns for our sample countries can be found in Bulíř, Čihák, and Šmídková, 2008 and Bulíř, Šmídková, Kotlán, and Navrátil, 2008.These deviations were caused either by domestic and external shocks that hit the sample economies after the forecast was produced and the policy stance decided or by poor analyses of the inflation factors. Our premise is that the unanticipated shocks, even sizable ones, may not affect inflation expectations providing they are randomly distributed over the medium-term. In contrast, the poor analyses, intentional or bona fide, are likely to compromise the central banks' credibility and affect inflation expectations.

Figure 1

Our key findings can be summarized as follows. Countries with more sophisticated monetary policy frameworks (Banco Central de Chile, the Czech National Bank, the ECB, and the Riksbank) generally highlighted in their inflation reports the same inflation factors as those identified by the model. We find much less accord between model-based and report-based inflation factors among lite targeters (the National Bank of Hungary, National Bank of Poland, and Bank of Thailand). Moreover, the banks with sophisticated frameworks are found to be more forward-looking in their reports than the lite targeters.

The remainder of the paper is organized as follows. First, we review the relevant literature. Second, we formulate a set of testable hypotheses and explain our methodology in greater detail. Third, we present the model, its country-specific calibrations and properties. Fourth, we discuss the results. The final section concludes.

II. Related Literature

The consensus among central bankers is "that transparency is not only an obligation for a public entity, but also a real benefit to the institution and its policies," (Issing, 2005). Central bankers have the ability to move the markets with their analyses (Blinder and others, 2008), even though it is difficult to explain the reasons of this ability. Is it really because their analyses are superior to other market participants, who in turn use these analyses to anchor their medium- and long-term expectation? To test this hypothesis, one needs to assess the quality of central bank inflation reports. One possibility is to look at the formal quality of central bank writing. Some banks write better than others (Fracasso, Genberg and Wyplosz, 2003) and well-written texts have a better chance of being understood as intended by the policymaker (Jansen, 2008). Another possibility is to measure the volume of information disclosed (Geraats, 2009). Finally, others have looked at consistency among various communication tools (Bulíř, Čihák, and Šmídková, 2008a and Bulíř Šmídková, Kotlán, and Navrátil, 2008). In general, banks with a well-developed forecasting and policy analysis systems write better, that is, more clearly.

The problem with the above methods is that nothing precludes central bank communication from being nicely worded, voluminous, consistent, and yet pure gibberish. Banks may produce gibberish for multiple reasons. First, the policymakers' objectives can differ from those stated officially and he/she would then communicate information that is not necessarily correct (or at least is not the most probable). For example, central banks pursuing opportunistic disinflation (Orphanides and Wilcox, 2002) may communicate positive output gaps or forthcoming fiscal impulses, thus justifying the need for a monetary stance that is tighter than implied by the inflation target and the state of the world (Ireland, 2007). Second, obsessively transparent central banks may decide to communicate information they understand imperfectly, with "noise" crowding out the correct part of the message (Dale, Orphanides, and Österholm, 2008). Third, some central bankers may be excessively talkative, sending signals that are either inconsistent or contradictory to the official views, or both (Rozkrut and others, 2007). Fourth, the central bank forecasting and policy analysis framework may be genuinely weak, producing systematically biased assessments of the economic environment. In practice, the four reasons are difficult to distinguish empirically, see, Šmídková, Bulíř, and Čihák (2008b).

III. Hypotheses to Be Tested: Are "Words" Confirmed by "Models"?

We want to know whether the inflation reports have enough analytical power to provide public with a good analysis. More specifically we want to test whether the real-time verbal assessments, that we call reported inflation factors, stand the test of ex-post, model-identified inflation factors. To this end we compute the correlation coefficient between the reported and model-identified inflation factors.

There are two possible outturns for the correlation coefficient (ρ) between the reported (α) and model-identified (ξ) inflation factors. First, the most likely outturn is that the correlation is positive ($0 < \kappa < \rho(\xi, \alpha) < 1$), where κ corresponds to the statistically significant value of the coefficient. In other words, the policymaker has reported some inflation factors similar to those identified by our model, but not at every observation. We interpret statistically significant values of ρ as an indicator of good inflation reports, with sufficient analytical power. In contrast, statistically insignificant values of ρ signal poor analytical quality of the reports. Second, the two sets of factors are orthogonal (or negative) $\rho(\xi, \alpha) \leq \kappa$. In these situations, we may only speculate that policymaker either has a completely different model in mind, follows a different information set than the model, or both. Whatever the reason, in this situation monetary policy communication is likely to be incomprehensible to the public, as the model-identified factors from the ex-post inflation accounting exercise repeatedly differ from the real-time reported inflation factors.

Empirically, our null hypothesis of a well-communicating central bank is that the inflation factors identified by the model correspond to inflation factors reported by the policymakers in their inflation reports, so that $\kappa < \rho(\xi, \alpha) \leq 1$. We will reject the null if the two sets of factors do not agree, so that $\rho(\xi, \alpha) \leq \kappa$. Our starting hypothesis is that lite targeters—that is, central banks with dual goals and weak forecasting and analytical systems—are more likely to have lower ρ's as compared to full-fledged targeters.

What is the appropriate significance level for κ? If we set the significance level too low, say, at 1 percent, we will make too many Type I errors, rejecting the null hypothesis, when the coincidence of ξ's and α's was still acceptable. If we set the significance level too high, say, at 50 percent, we will fail to reject the wrong null hypothesis (Type II error). Given the potential for measurement errors and the short sample, we are more concerned about the Type I error than about the Type II error. After experimenting with various significance levels, we base our analysis on the 20 percent significance level. It turns out that this significance level in our sample typically corresponds to a correlation coefficient of 0.2 or higher (κ=0.2).

To account for the unknown lead with which the central banks report the inflation factors, the correlation coefficients of the model-identified and reported inflation factors will be constructed over reasonable leads (from zero to six quarters). The reported inflation factors either lead the model-identified factors or at least to occur during the same quarter, as we excluded backward-looking assessments from the reported factors. This distinction is straightforward as all reports clearly separate backward- and forward-looking chapters. Regarding the model-identified factors, we record them only when they are observed in the data. For example, the model would identify a price shocks from an increase in administered prices in the quarter in which it occurred and possibly also its second-round effects during subsequent quarters. In contrast, the policymaker may foresee such a factor with a lead of several quarters—for example, because the government mulls the increase—and may report its impact on future inflation, thus leading the model. Of course, the policymaker may decide against communicating certain factors with a lead and report them only in the current period. For example, following erratic executions of pre-announced price adjustments the central bank may hesitate to incorporate such announcements into its forecasts.

If the reported and model-identified inflation factors agree, then we cannot reject the null hypothesis of analytically strong inflation report and well-communicated monetary policy. If, however, the model-identified and reported inflation factors disagree, then either the policymaker communicates "wrong" inflation factors as compared to factors "correctly" identified by the model ("writes gibberish") or the model fails to capture the inflation factors that the policymaker correctly observes. However, we find it hard to believe that our models would consistently report wrong inflation factors, given their forecasting performance.

A. Data Transformation

To test our hypothesis, we use datasets of Chile, the Czech Republic, the eurozone, Hungary, Poland, Sweden, and Thailand. While the ECB is technically not an inflation targeting central bank, its communication strategy (declaration of the price stability objective, publication of forecasts and detailed reports, and so on) makes it comparable to the rest of the sample. The sample period for the reported inflation factors is from 1999 to 2007 for the ECB and from 2000 to 2005 for the rest. The sample period for the model-identified factors is determined by availability of consistent data (see Annex I for the description of the sample).

Model-identified inflation factors

To obtain the model-identified inflation factors, we build a canonical output gap model for each country. Each country model draws on nine observable series: domestic and foreign consumer price index (p and p^*); domestic and foreign inflation target (π^T and π^{*T}), domestic and foreign gross domestic product (y and y^*), domestic and foreign 3-month interbank interest rate (i and i^*), and nominal exchange rate (s). CPI, GDP, interest, and exchange rate data are from the *International Financial Statistics* database, and inflation target data are from the national central bank websites.

The model—described below—assumes that the observed deviations of economic variables from their respective long-term values are caused by directly unobserved economic shocks. For example, inflation may deviate from its target owing to aggregate supply and demand shocks, exchange rate shocks, shocks to external variables (interest rates, output, and inflation), and monetary policy shocks. The estimation of the unobserved shocks is based on the model and information contained in the observed variables, whereas the link between the observed and unobserved variables is represented by the economic model itself. The estimated shocks then identify the corresponding model-based inflation factors. Each inflation factor captures the impact of the particular shock on inflation and the transmission of the shock to inflation factor depends on the model structure. When impacts of all shocks defined in the model are accounted for, we get the decomposition of inflation to inflation factors. We call such decomposition inflation accounting, as it is similar to the growth accounting exercise of Chari, Kehoe and McGrattan (2007).

The decomposition of the inflation factors depends on the specific model used to examine the data and we offer two reasons for choosing the reduced-form new-Keynesian model. First, the sample banks' forecasting and policy analysis systems relied at least partly on a version of this model during the period under consideration. Second, the model is relatively simple, easy to calibrate for economies in question, predicts inflation well, and offers interpretation simplicity. Regarding the interpretation properties, the model-identified decomposition of inflation factors (demand and supply, external and monetary policy factors) directly corresponds to the inflation factors reported in the inflation reports. In contrast, it would be significantly more difficult to map the structural shocks from a fully micro-founded dynamic general equilibrium model (DGE) to the reported inflation factors. Our modeling choice in this particular exercise does not imply any endorsement of reduced-form models over the DGE frameworks.

Reported inflation factors

To obtain reported inflation factors we follow the methodology proposed by Guthrie and Wright (2000) and Bulíř, Šmídková, Kotlán, and Navrátil (2008). From the sample central banks' inflation reports we extract all verbal assessments, cataloguing them into supply, demand or exchange rate categories, further dividing into subcategories, and classifying as pushing the rate of inflation either higher or lower. Each verbal factor is given an equal weight, because inflation reports generally do not provide information on the factors' quantitative importance. To this end, we denote factors that put upward pressure on the inflation rate as 1, factors that put downward pressure on the inflation rate as –1, and ambiguous factors as 0. All factors were then aggregated across categories to obtain a net index-like measure of the inflation factors that the policymaker reports in any given quarter. Demand, supply, and external categories are summarized in Figure A1.1.

There are several potential criticisms of this approach. First, it has been argued that inflation reports are primarily "staff" documents and that the policymaker's views are better found in other documents, such as press releases or ex post interviews. We find the staff-to-policymaker difference largely superficial—there is little additional information contained in high-frequency communication besides timing. For example, augmenting the ECB's monthly bulletins with information from the press releases yields negligible information gains (Bulíř, Čihák, and Šmídková, 2008). Second, the reported factors contain the policymaker's real-time uncertainty about the data, the underlying model, or vis-à-vis the forecast (Šmídková, 2005). This is in our view a reason to experiment with alternative significance levels for the estimated correlation coefficients, but not a reason to dismiss the methodology.

Third, it could be argued that the simple grading of inflation factors (–1; 0; 1) does not capture their relative importance for future inflation. However, the magnitude does matter for pairwise correlations as these calculations capture the direction of inflation factors as compared to the size of these factors.

B. The Model

The model employed for the estimation of economic shocks and subsequent identification of inflation factors is a canonical reduced-form new-Keynesian model that has been widely used for forecasting and policy analysis in central banks and other institutions (Berg, Karam and Laxton, 2006). The model consists of four behavioral equations (representing aggregate demand, aggregate supply, the policy-reaction function, and the uncovered interest rate parity condition) and several identities (see Annex II for detailed description of the model)

To avoid any ad hoc detrending of observed time series, the model structure encompasses both nominal and real deterministic trends so as to use directly the observed nonstationary time series. The nominal trend is unique and is determined by the inflation target in the domestic and foreign economy. Four different real trends are used to replicate the observed data: real GDP growth, real exchange rate, and domestic and foreign real interest rates. The trend changes in the real exchange rate and in domestic and foreign real interest rates are bounded via the real version of the uncovered interest rate parity. Real trends, shocks hitting those trends, and the business cycle (the output gap) are estimated as unobserved variables jointly with estimates for all other economic shocks.

The canonical model is calibrated to capture the country-specific features along the lines of Bulíř and Hurník (2006), following the so-called minimal econometric approach suggested by Geweke (1999). To this end, we rely on the analysis of (i) impulse responses, (ii) the forecast error variance decomposition, and (iii) the recursive forecast (see Annex III). Table A2.1 summarizes parameter calibration for our sample countries, comparing them to the all-purpose calibration values suggested by Berg, Karam and Laxton (2006) and to their calibration for Canada. The country-specific models predict inflation reasonably well, with reasonable contributions of past inflation, output gap, the exchange rate, and so on as shown in the sample mean square errors (Table A3.2) that are significantly smaller than the errors from the same-variable vector autoregressive (VAR) model. Visually, the model forecasts predict the turning points in inflation and the missed turning points could be easily traced back to supply shocks that our simple model does not capture, such as indirect tax changes and administrative price adjustments described in the reports (Figure A3.1). The forecast error variance decomposition charts capture the key stylized facts, such as negligible exchange rate transmission channel for the eurozone, limited role of domestic interest rate in countries that shadow the ECB (Hungary and Sweden), and so on (Figure A3.2).

Estimation of Unobserved Variables and Inflation Accounting

Obtaining the model-identified inflation factors involves solving the model for its reduced form, substituting non-predetermined forward-looking variables with a linear combination of past shocks (Blanchard and Kahn, 1980 or Uhlig, 1995). A reduced-form of the model then serves as a starting point for the estimation of economic shocks based on the method of the Kalman filtration. The Kalman filter applies a reduced-form of the model extended for measurement equations that map observed variables to the unobserved, jointly representing the 'state description of the model':

$$y_t = Zx_t + \varepsilon_t \quad (1)$$

$$x_t = Tx_{t-1} + \nu_t, \quad (2)$$

where x denotes the vector of unobserved state variables, y is the vector of observed (measurement) variables, ε is a random vector called the process noise, and ν is the measurement noise. It assumed that the distribution of random noise vectors ε and ν as well as that of the initial state ($t=0$) of the state vector x are Gaussian.

Based on the state form of the model and using observed variables (Table 1), the Kalman filter identifies all unobserved variables that are a part of the model, including the shocks. For linear systems the Kalman filter represents an optimum estimate in terms of the least squares criterion (Hamilton, 1994). Application of the filter itself takes on the recursive algorithm form, wherein the conditional probability density of state variables gets updated based on observed variables.

Table 1

The first step of the Kalman algorithm is the prediction step, during which equation (2) is used to estimate the predictive probability density of states at time *t* based on the previous conditional probability density at time *t-1*. This probability density is nonexistent in the first period of the data sample and is therefore substituted with a random vector with a mean value and the unconditional variance of state variables described by the equation (2). Due to the presence of trends within the model and resulting nonstationarity of some variables, the unconditional variance does not have a finite value, a problem solved by employing the diffuse Kalman filter (De Jong, 1991). The second step of the Kalman algorithm is filtration step, representing an update of the predictive probability density based on information contained in the observed data, using the measurement equation (1). Additional information drawn from the observed data enables a refined estimate of the state variables, also including the estimate of the shocks. In addition, we employ the smoothing step of the filter which, using the complete information from the observed data (Harvey, 1989).

The application of the Kalman filter results in the identification of the unobserved state variables, including economic shocks. The estimated realizations of different shocks are recursively used for historical simulations of the model, quantifying the exact, time-varying effect of different shocks on inflation (Smets and Wouters, 2007). We thus obtain an estimate of the impact of each particular realization of shocks (such as the exchange rate shock, supply shock, and so on) on the deviation of inflation from its target and denote these as the model-identified inflation factors. By summing up all the inflation factors we obtain are the actually observed realizations of inflation. Inflation unexplained by supply, demand, and exchange rate (and other foreign) shocks is residually attributable to monetary policy shocks.

IV. THE RESULTS

The main finding from our analysis is that the full-fledged inflation targeters have generally reported inflation factors similar to those identified by the model, while the reporting record of the lite targeters has been mixed. Regarding the timing of the reported inflation factors, whereas the demand inflation factors were generally reported in a forward-looking manner, as it is to be expected under inflation targeting, the supply and exchange rate inflation factors were identified contemporaneously. There are no correct and wrong leads between the model-identified and reported factors—these depend on the communication strategy of each central bank and we let the data to pick the strongest relationship. In the following sections we report the demand, supply, exchange rate, and monetary policy inflation factors; first going over the cross-country properties of the model-identified inflation factors and, second, discussing country-specific correlations between the model-identified inflation factors and reported inflation factors.

Regarding the cross-country properties of data, we find that the model-identified inflation factors have been largely uncorrelated across the sample countries during 2000–06, with the exception of the eurozone and Sweden. Also, the demand and exchange rate inflation factors among the three Central European countries are uncorrelated.[5] Of the three Central European countries Hungary was the closest to the eurozone, an observation corresponding to other studies that found tighter shock correlation than in the Czech Republic and Poland (see, for example, CNB (2007). The monetary policy inflation factors were tightly correlated between the eurozone and Sweden and between the Czech Republic and Hungary.

A. Aggregate Demand Inflation Factors

The cross-country correlations of the model-identified demand inflation factors (Table 2) were positive among the Central European countries, between the eurozone and Sweden, and Chile and the eurozone, the latter mostly likely on the account of its export exposure (Table 4). These idiosyncratic correlations give us additional confidence about the model estimates—the central banks seemed to have observed a similar international business cycle.

Table 2

The model-identified demand factors coincided fairly well with the reported factors of full-fledged inflation targeters (Chile, the Czech Republic, and Sweden) and also in the eurozone, while the record of lite targeters (Hungary, Poland, and Thailand) was less impressive (Figure 2 and for numerical values of the correlation coefficient see Annex IV). Among the full-fledged targeters, in Chile the sample contemporaneous correlation was 0.8 and the 2-quarter lead correlation was 0.6 (meaning that the reports lead model-identified factors by 2 quarters). In the Czech Republic the correlation increased sharply after early 2002 when the central bank abolished its expert-based inflation forecast, replacing it with a

[5] In Tables 2-5 we do not include Thailand. Owing to data limitations we simulated the Thai model only from 2001 and thus have a shorter model-based inflation factors series than for the rest. Incidentally, Thai inflation factors in the shortened sample were not correlated with any of the other sample countries

model-based forecast, improving also the drafting of the reports. The Czech reports are forward-looking—the contemporaneous correlations are low, increasing with two and four leads. Sweden had high contemporaneous and 2-lead correlation between the two factors during 2000–02, however the value of the coefficient declined sharply toward the end of the sample. The ECB also started with a close match between the two series, however its record worsened toward the end of the sample (the ECB's Economic Bulletins repeatedly mentioned expansionary fiscal stance in the early 2006, while the model identified slack in the economy). Also, contemporaneous and leading correlations for the ECB are very close to each other for most of the sample, presumably reflecting the persistence of the demand factors and their mechanic recording in the ECB's reports. Thailand's correlations were mostly negative, especially later in the sample.

Figure 2

Among lite targeters Hungary had a contemporaneous correlation of 0.4, however, its series does not start until the end of 2001, so the rolling window is the shortest. Poland's correlations were actually negative, mostly on the account of repeated predictions of fiscal expansions that did not materialize. This finding is not entirely surprising—it has been observed by Rozkrut, and others (2007) that the Polish policymakers have tended to send mixed signals.

B. Aggregate Supply Inflation Factors

The cross-country correlations of the model-identified supply factors were mostly positive, reflecting the common disinflation objective in our sample countries (Table 3). The model-identified supply inflation factors coincided again more with those reported in the inflation reports of full-fledged inflation targeters (Chile, the Czech Republic, and Sweden) and the eurozone than in the lite targeters group (Hungary and Poland) (Figure 3 and Annex IV). Thailand's performance in this exercise was again closer to the group of the lite targeters.

Table 3

Figure 3

Chile had high leading and contemporaneous correlations, while in the Czech Republic only the contemporaneous correlation was significant. To the extent the supply inflation factors in emerging market countries are driven by administrative price changes, these correlations reflect the chosen reporting practices—Chile announces these price shocks with a lead, whereas the Czech Republic announces them mostly in the current quarter. The correlations in the eurozone and Sweden are also significant and relatively stable during the sample period. The track record in the rest of the sample is again much less convincing, with correlations barely significant (and positive) in Hungary and Thailand and mostly negative in Poland.

C. Exchange Rate Inflation Factors

The model-identified exchange rate factors were all highly correlated across countries, reflecting the common underlying exchange rate series (Table 4). The Czech Republic, Hungary, Poland, and Sweden were hit with the euro exchange rate shocks, while Chile, the eurozone, and Thailand were hit with the dollar exchange rate shocks.

Table 4

The distinction between the full-fledged and lite targeters observed in the analysis of the demand and supply factors is largely missing in the exchange rate inflation factor correlations (Figure 4). While the Czech central bank anticipated and reported the exchange rate factors, with a 2-quarter lead, the correlation was lower and less stable in Chile, Sweden, and the eurozone. In contrast, Polish and Thai central banks reported the exchange rate inflation factors well. The difference between contemporaneous and leading correlations need not be interpreted as a lack of analytical power as it presumably reflects central banks' communication strategy and uncertainty about transmission. The Bank of Thailand did not make any forward-looking statements about exchange rates during the sample period, whereas the ECB made mostly forward looking statements in the beginning of the sample period, stressing more the contemporaneous component toward the end of the sample.

Figure 4

D. Monetary Policy Shocks and Inflation Factors

After all model-identified inflation factors have been accounted for, inflation is ultimately affected by the stance of the monetary policy. The estimates of the monetary policy shocks measure how tight/loose was the monetary stance relative to the state of the world and the inflation target, while the resulting monetary policy inflation factors measure the impact of these shocks on deviation of inflation from the inflation target. Finding a corresponding forward-looking variable in the inflation reports is difficult for a number of reasons. While some central banks report intentional non-fulfillments of the inflation target and apply so-called caveats, the practice is not uniform across the sample. In addition, most banks publish detailed ex-post explanations of the non-fulfillments, but these are backward-looking, not forward-looking analyses, and we could not incorporate them into our methodology.

Using our model we can identify suboptimal monetary policy periods ex post, when the interest rates were higher/lower than warranted by the rule and all other information available. Such periods may imply a policymaker's mistake, more likely, however, they result from intentionally slow reaction to other shocks. For example, following an exogenous appreciation shocks the policymaker ought to have cut the policy rate. In practice, he may not have done so for a variety of reasons: he already cut the rate in the current quarter and wants to pause for a while given the model uncertainty; he may be unsure about the level of equilibrium exchange rate; or he may want to avoid disturbing the foreign exchange markets any further.

We find relatively weak correlations of model-identified monetary policy factors across our sample countries (Table 5). All countries were correlated with the eurozone and Sweden had the tightest correlation, presumably reflecting Riksbank's close attention to ECB actions. Intuitively, policymakers that talk to each other and whose countries are faced with similar demand and supply shocks are bound to lean in the same direction. In contrast, Czech and

Polish monetary policy driven inflation factors were correlated negatively with those in the eurozone, presumably on the account on reacting either more slowly or more aggressively to the underlying shocks than the ECB. Poland stands as a true outlier—besides a weak positive correlation vis-à-vis the Czech Republic, its model-identified monetary policy factors were negatively correlated with the remaining of the sample countries.

Table 5

A few observations are worth mentioning. In absolute terms the volatility of the monetary policy inflation factors was the lowest in the eurozone (with a 2000–06 standard deviation of 0.2); comparable in Chile, the Czech Republic, Hungary, Sweden, and Thailand (standard deviation of about 1.0); and the highest in Poland (standard deviation of 2.3) (Figure 5). In terms of direction, the 2000–06 monetary policy inflation factors add up to close to nil for the eurozone, the Czech Republic, and Sweden, implying a cyclically neutral stance. In contrast, the sums are large and positive for Thailand and large and negative for Chile, Hungary and Poland, implying loose and tight stance vis-à-vis the state of the world and the inflation target. Our interpretation is that the central banks in Chile, Hungary and Poland lacked inflation credibility of the ECB or the Riksbank and were forced to overcompensate their monetary stance. In contrast, the loose policy signaled by the model in Thailand is presumably a spillover from the low nominal rates in Japan.

Figure 5

V. Conclusions

We find that central banks with more sophisticated forecasting frameworks (Banco Central de Chile, the Czech National Bank, European Central Bank, and Riksbank) generally identified in their inflation reports the same inflation factors as those identified ex post by the model. Even with noisy data and all measurement and prediction errors, the countries' inflation reports identified on average some 50–60 percent of all inflation factors correctly, that is, in line with the new-Keynesian model that we use to capture the state of the world in our sample countries. Whereas demand factors were generally identified in the inflation reports in a forward-looking manner, as it is to be expected under inflation targeting, supply and exchange rate factors were identified mostly contemporaneously. Nevertheless, the results also confirm that each policymaker occasionally gets the picture wrong. We find much less accord between model-identified and report-based inflation factors among lite targeters (the National Bank of Hungary and National Bank of Poland) and the Bank of Thailand—the correlations between report-based and model-based inflation factors were either statistically insignificant or even negative. Some of these central banks have missed most inflation factors identified ex-post by the model.

The failure of lite targeters to report verbally the inflation factors identified by the model can result from an alternative monetary policy objective, noisy data, a lack of central bank credibility, or an imperfect forecasting framework. First, the inflation targeting framework is predicated on the assumption that the central bank observes the economic environment and formulates monetary policy according to a well-specified policy rule. If the policymaker maintains a dual or unspecified objective, such as, nominal exchange rate stability in the case of Hungary, he is likely to have difficulty in formulating and achieving these objectives. Second, we are likely to find a low correlation between the two sets of data also if the real-time, inflation-report data are revised substantially. For example, in Poland the policymaker repeatedly misjudged the magnitude of the fiscal impulse. Third, the model implicitly incorporates the assumption of monetary policy credibility, that is, in order to fulfill the target the policymaker needs to set the policy rates given the state of the world and his inflation target. Of course, in the absence of such credibility, especially soon after the introduction of the inflation targeting regime, the rates need to be higher, generating an impression of a too tight monetary policy stance. Finally, the policymaker may rely on a poorly designed forecasting framework that generates incorrect descriptions of inflation factors.

References

Batini, Nicoletta, and Douglas Laxton, 2007, "Under What Conditions Can Inflation Targeting Be Adopted? The Experience of Emerging Markets," in *Monetary Policy under Inflation Targeting*, ed. By Frederic Mishkin and Klaus Schmidt-Hebbel, (Santiago, Chile: Central Bank of Chile). Available at: http://www.bcentral.cl/eng/studies/working-papers/406.htm

Berg, Andrew, Philippe Karam, and Douglas Laxton, 2006, "A Practical Model-Based Approach to Monetary Policy Analysis—Overview," IMF Working Paper 06/81 (Washington: International Monetary Fund). Available at: http://www.imf.org/external/pubs/ft/wp/2006/wp0681.pdf.

Bernanke, Ben S., and Michael Woodford, 1997, "Inflation Forecasts and Monetary Policy," *Journal of Money, Credit, and Banking*, Vol. 29, No. 4, pp. 653–84.

Beneš, Jaromír, Jaromír Hurník and David Vávra, 2008, "Exchange Rate Management and Inflation Targeting: Modeling the Exchange Rate in Reduced-Form New Keynesian Models", *Czech Journal of Economics and Finance*, Volume 58, Issue 3–4, pp.166-194.

Blanchard, J., Olivier, and Charles, M., Kahn, 1980, "The Solution of Linear Difference Models under Rational Expectations", *Econometrica*, Vol. 48, No. 5, p. 1305-1312.

Blinder, Alan S., Michael Ehrmann, Marcel Fratzscher, Jakob de Haan, and David-Jan Jansen, 2008, "Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence," *Journal of Economic Literature*, Vol. 46, Iss. 4, pp. 910–45.

Bulíř, Aleš, Martin Čihák, and Kateřina Šmídková, 2008a, "Writing Clearly: ECB's Monetary Policy Communication," IMF Working Paper 08/252. (Washington, DC: International Monetary Fund). Available at: http://www.imf.org/external/pubs/ft/wp/2008/wp08252.pdf.

Bulíř, Aleš, Martin Čihák, and Kateřina Šmídková, 2008b, "Hits and Misses: Ten Years of Czech Inflation Targeting (Introduction)," *Czech Journal of Economics and Finance,* Vol. 58, Issue 9–10, pp. 398-405. Available at: http://journal.fsv.cuni.cz/storage/1139_0__Šmídková-bulíř-Čihák.pdf.

Bulíř, Aleš, Kateřina Šmídková, Viktor Kotlán, and David Navrátil, 2008, "Inflation Targeting and Communication: It Pays Off to Read Inflation Reports." IMF Working Paper 08/234. (Washington, DC: International Monetary Fund). Available at: http://www.imf.org/external/pubs/ft/wp/2008/wp08234.pdf.

Bulíř, Aleš, and Jaromír Hurník, 2006, "The Maastricht Inflation Criterion: How Unpleasant is Purgatory?" *Economic Systems*, Vol. 30, pp. 385–404.

Carare, Alina, and Mark R. Stone, 2006, "Inflation Targeting Regimes," *European Economic Review*, Vol. 50 (July), pp. 1297-1315.

Chari, V.V., Patrick J. Kehoe, and Ellen R. McGrattan, 2007, "Business Cycle Accounting," *Econometrica*, Vol. 75 (May), pp. 781–836.

Czech National Bank, 2007, "Analyses of the Czech Republic's Current Economic Alignment with the Euro Area, 2007," (Prague: Czech National Bank). Available at: http://www.cnb.cz/m2export/sites/www.cnb.cz/en/monetary_policy/strategic_documents/download/analyses_of_alignment_2007.pdf.

Dale, Spencer, Athanasios Orphanides, and Pär Österholm, 2008, "Imperfect Central Bank Communication–Information Versus Distraction," IMF Working Paper No. 08/60 (Washington: International Monetary Fund). Available at: http://www.imf.org/external/pubs/ft/wp/2008/wp0860.pdf.

De Jong, Piet, 1991, "The Diffuse Kalman filter", *The Annals of Statistics*, Vol. 19, Issue 2, p. 1073–83.

Ehrmann, Michael, and Marcel Fratzscher, 2007, "Communication by Central Bank Committee Members: Different Strategies, Same Effectiveness?" *Journal of Money, Credit and Banking*, Vol. 39 (Issue 2–3), pp. 509–541.

Fracasso, Andrea, Hans Genberg, and Charles Wyplosz, 2003, "How Do Central Banks Write?" Geneva Reports on the World Economy, Special Report 2, The Center for Economic Policy Research. Available at: http://hei.unige.ch/~wyplosz/IR_fgw.pdf.

Geraats, Petra M., 2009, "Trends in Monetary Policy Transparency," CESifo Working Paper No. 2584. Available at: http://www.cesifo.de/~DocCIDL/cesifo1_wp2584.pdf.

Geweke, John, 1999, "Computational Experiments and Reality", *Computing in Economics and Finance*, Society for Computational Economics, No. 401.

Guthrie, Graeme, and Julian Wright, 2000, "Open Mouth Operations*,"* *Journal of Monetary Economics*, Vol. 46, Issue 2, pp. 489–516.

Ireland, Peter N., 2007, "Changes in the Federal Reserve's Inflation Target: Causes and Consequences," *Journal of Money, Credit and Banking*, Vol. 39, No. 8, pp.1851–82.

Issing, Otmar, 2005, "Communication, Transparency, Accountability: Monetary Policy in the Twenty-First Century," Federal Reserve Bank of St. Louis *Review*, March/April 2005, Vol. 87, Issue 2, pp. 65–83. Available at: http://research.stlouisfed.org/publications/review/05/03/part1/Issing.pdf.

Hamilton, James, 1994, *Time Series Analysis*, (Princeton: Princeton University Press).

Harvey, C., Andrew, 1989, *Forecasting, structural time series models and the Kalman filter*, (Cambridge: Cambridge University Press).

Hurník, Jaromír, Ondra Kameník, and Jan Vlček, 2008, "The History of Inflation Targeting in the Czech Republic Through the Optic Of a Dynamic General Equilibrium Model," *Czech Journal of Economics and Finance*, Volume 58, Issue 11–12, pp. 454–469. Available at: http://journal.fsv.cuni.cz/storage/1143_4__hurník-kameník-vlček.pdf.

Orphanides, Athanasios, 2004, "Monetary Policy Rules, Macroeconomic Stability, and Inflation: A View from the Trenches," *Journal of Money, Credit and Banking*, Vol. 36 (April), pp. 151–75.

Orphanides, Athanasios and David W. Wilcox, 2002, "The Opportunistic Approach to Disinflation," *International Finance*, Vol. 5 (Spring), pp. 47–71.

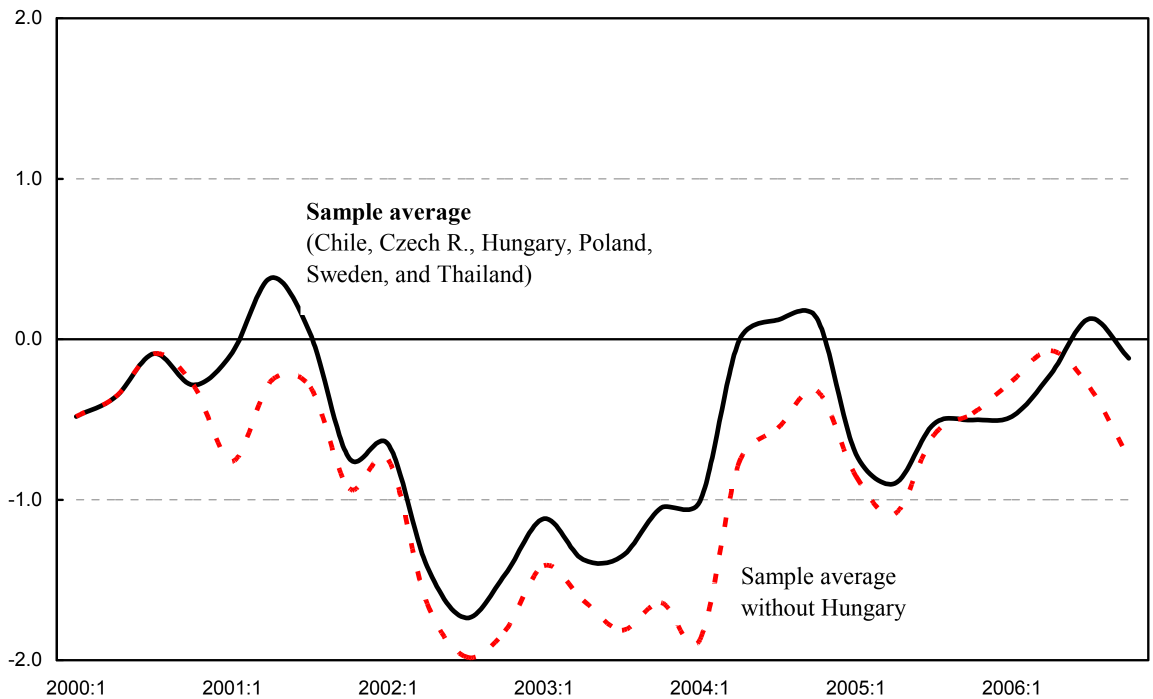
Rozkrut, Marek, Krzysztof Rybiński, Lucyna Sztaba, and Radosław Szwaja, 2007, "Quest for Central Bank Communication: Does It Pay to Be 'Talkative'?" *European Journal of Political Economy*, Vol. 23, pp. 176–206.

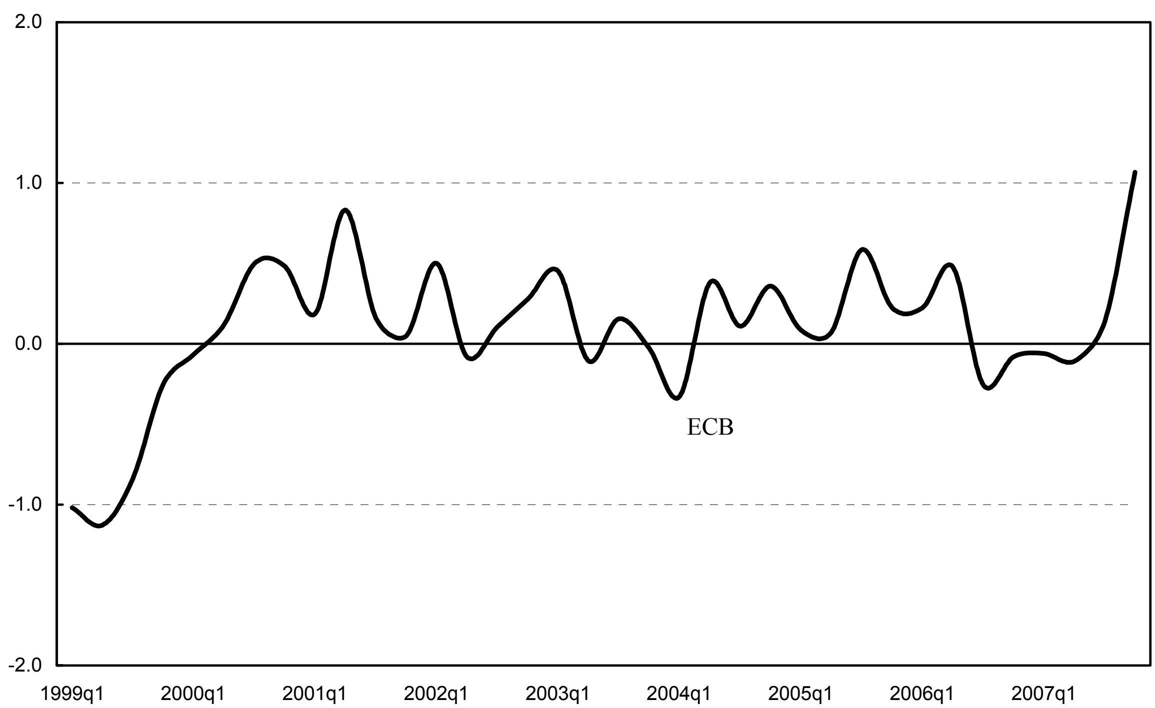
Smets, Frank, and Rafael Wouters, 2007, "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *American Economic Review*, Vol. 97 (June), pp. 586–606.

Šmídková, Kateřina, 2005, "How Inflation Targeters (Can) Deal with Uncertainty," *Czech Journal of Economics and Finance*, Vol. 55, Issue 7-8, pp. 316–32. Available at: http://journal.fsv.cuni.cz/storage/1024_s_316_332.pdf.

Šmídková, Kateřina, Aleš Bulíř, and Martin Čihák, 2008, "Hits and Misses: 10 Years of Czech Inflation Targeting," *Czech Journal of Economics and Finance*, Volume 58, Issue 11–12, pp.398–405. Available at: http://journal.fsv.cuni.cz/storage/1139_0__Šmídková-bulíř-Čihák.pdf

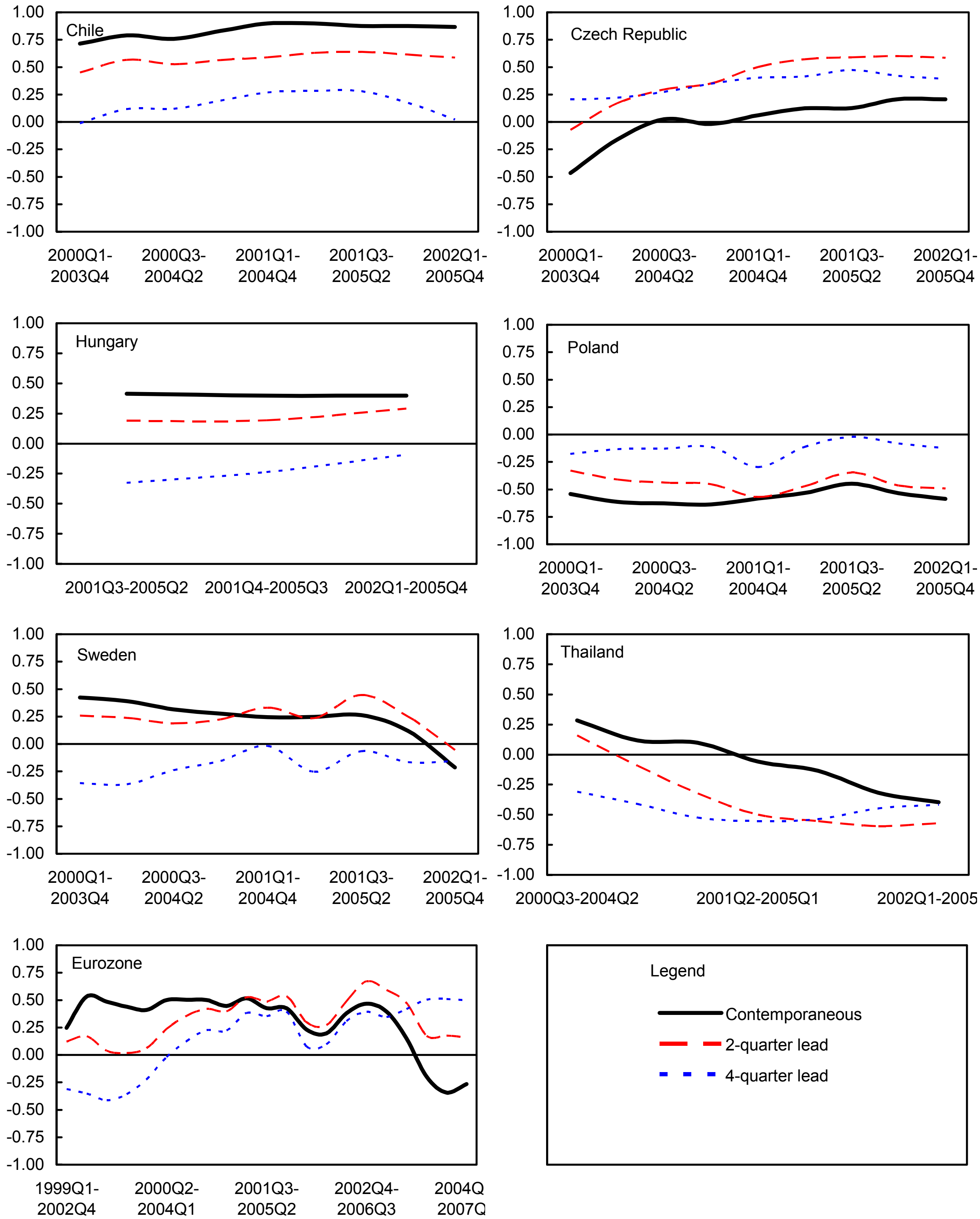
Figure 1. Deviations from the Inflation Target
(In percentage points)





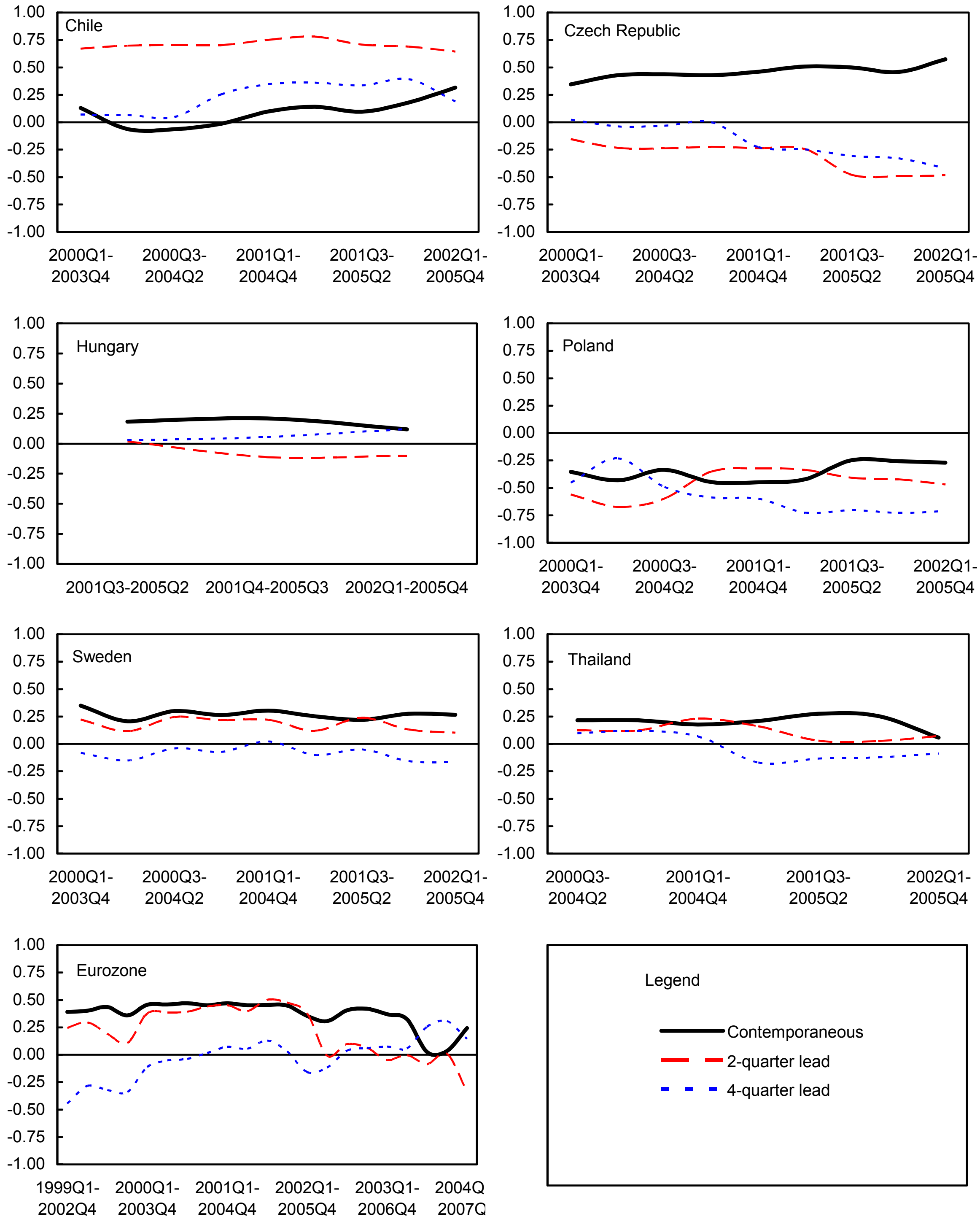
Source: Central bank websites.

Figure 2. Aggregate Demand Shocks
(Rolling 16-quarter correlation coefficients)



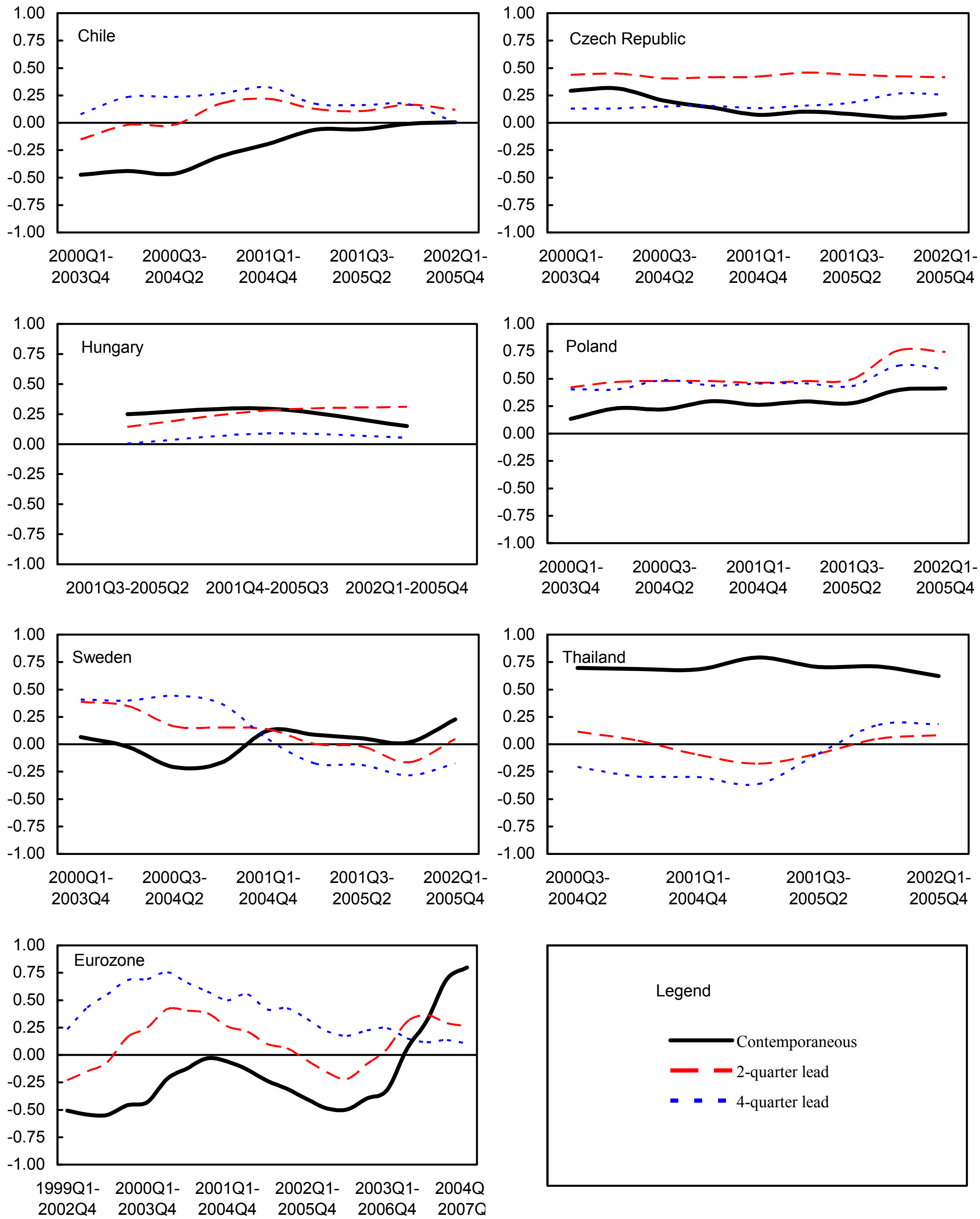
Notes: We calculate rolling correlation coefficients between the model-based and reported inflation factors. The black line denotes contemporaneous correlations, while the dashed red and dotted blue lines denote correlations where the reported factors lead the model-based factors by 2 and 4 quarters, respectively.

Figure 3. Aggregate Supply Shocks
(Rolling 16-quarter correlation coefficients)



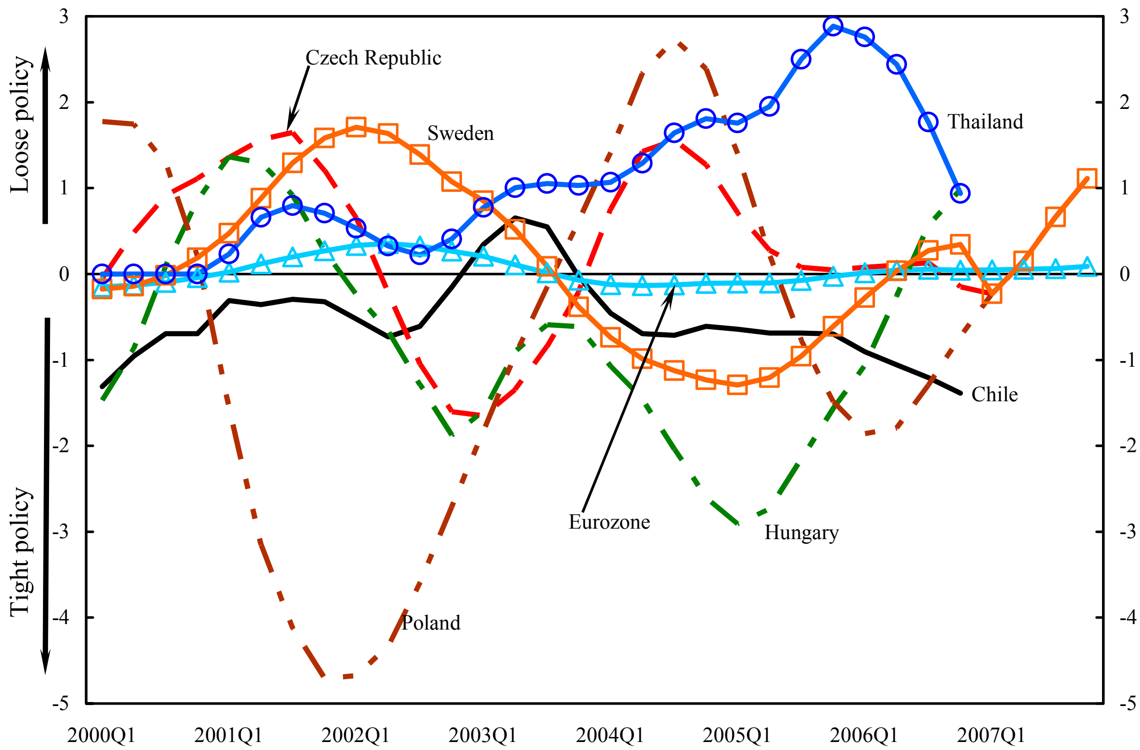
Notes: We calculate rolling correlation coefficients between the model-based and reported inflation factors. The black line denotes contemporaneous correlations, while the dashed red and dotted blue lines denote correlations where the reported factors lead the model-based factors by 2 and 4 quarters, respectively.

Figure 4. Exchange Rate Shocks
(Rolling 16-quarter correlation coefficients



Notes: We calculate rolling correlation coefficients between the model-based and reported inflation factors. The black line denotes contemporaneous correlations, while the dashed red and dotted blue lines denote correlations where the reported factors lead the model-based factors by 2 and 4 quarters, respectively.

Figure 5. Monetary Policy Impact on Inflation, 2000-2007



Source: Decomposition using a reduced-form new-Keynesian model.

Table 1. The List of Variables

Model variable	Source
Domestic prices	Consumer price index (CPI)
Foreign prices	Consumer price index in the eurozone (the Czech Republic, Hungary, Poland, and Sweden) or U.S. (Chile, Thailand, the eurozone)
Inflation target	Whenever needed, (i) midpoints of the target ranges were used to obtain point targets; (ii) missing intra-year target observations were estimated with other unobserved variables; (iii) eurozone's price stability objective of 2 percent
Domestic output	Real GDP
Foreign demand	Output gap derived from a band-pass filter, eurozone's GDP for the Czech Republic, Hungary, Poland, and Sweden and U.S. GDP for Chile, Thailand, and the eurozone
Nominal exchange rate	The spot exchange rate in domestic currency term vis-à-vis the euro (the Czech Republic, Hungary, Poland, and Sweden) and the U.S. dollar (Chile, Thailand, and the eurozone)
Nominal short-term interest rates	3-month interbank rate
Foreign nominal short-term interest rates	3-month interbank rate in the eurozone (the Czech Republic, Hungary, Poland, and Sweden) and the U.S. (Chile, Thailand, and the eurozone)

Table 2. Contemporaneous Correlations Among Model-Based Estimates of Demand Shocks

	Chile	Czech Republic	Hungary	Poland	Sweden
Czech Republic	-0.28				
Hungary	-0.10	**0.32**			
Poland	-0.25	**0.30**	-0.01		
Sweden	0.10	**-0.38**	-0.04	**-0.82**	
Eurozone	**0.70**	-0.21	-0.10	**-0.67**	**0.57**

Notes: Statistically significant correlations at 20 percent are in bold.

Table 3. Contemporaneous Correlations Among Model-Based Estimates of Supply Shocks

	Chile	Czech Republic	Hungary	Poland	Sweden
Czech Republic	**0.26**				
Hungary	0.11	0.19			
Poland	-0.10	0.16	0.18		
Sweden	**0.36**	0.15	**0.39**	-0.09	
Eurozone	**0.34**	0.17	**0.37**	0.04	**0.84**

Notes: Statistically significant correlations at 20 percent are in bold.

Table 4. Contemporaneous Correlations Among Model-Based Estimates of Exchange Rate Shocks

	Chile	Czech Republic	Hungary	Poland	Sweden
Czech Republic	**-0.49**				
Hungary	**-0.52**	**0.66**			
Poland	**-0.54**	**0.68**	**0.70**		
Sweden	**0.42**	**-0.26**	**-0.48**	**-0.73**	
Eurozone	**0.75**	**-0.40**	**-0.51**	**-0.62**	**0.76**

Notes: Statistically significant correlations at 20 percent are in bold.

Table 5. Contemporaneous Correlations Among Model-Based Estimates of Monetary Policy Shocks

	Chile	Czech Republic	Hungary	Poland	Sweden
Czech Republic	**-0.35**				
Hungary	-0.04	**0.28**			
Poland	-0.19	0.21	**-0.43**		
Sweden	0.24	-0.24	**0.58**	**-0.86**	
Eurozone	**0.29**	**-0.35**	**0.31**	**-0.92**	**0.92**

Notes: Statistically significant correlations at 20 percent are in bold.

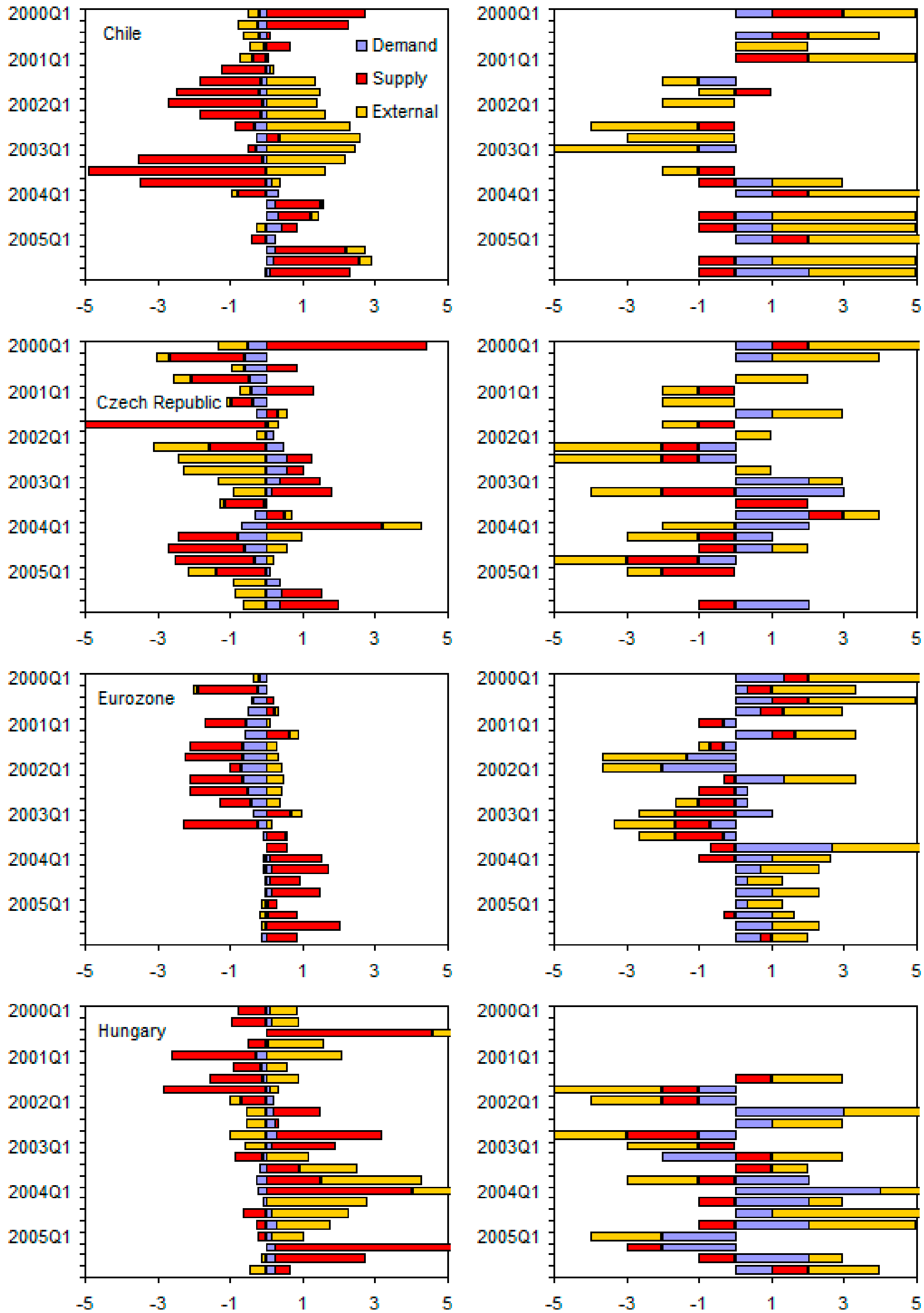
ANNEX I

Table A1.1. Sample Country Characteristics

Country	Inflation targeting introduced	"Fully-fledged IT" or "IT lite"?[1]	Name, frequency, and availability of reports	Type of inflation forecast	Inflation[2] and type of price index	Sample period for model simulations
Chile	1991	Fully-fledged	Monetary policy report, three times a year; http://www.bcentral.cl	Conditional on unchanged policy rates	2.6 CPI	1994-2006
Czech Republic	1998	Fully-fledged	Inflation report, four times a year; www.cnb.cz	Conditional on unchanged policy rates until mid-2002, unconditional thereafter	2.3 CPI	1996-2007
The eurozone	N.A.	Formally not an inflation targeter; has an objective of price stability	Monthly bulletin, 12 times a year; http://www.ecb.int	Conditional on market interest rates expectations and unchanged bilateral exchange rates	2.2 HICP, Harmonized index of consumer prices	1996-2007
Hungary	2001	Lite	Report on inflation, four times a year; www.mnb.hu	Conditional on unchanged policy rates and exchange rates	5.9 CPI	1995-2006
Poland	1999	Lite	Inflation report, four times a year; www.nbp.pl	No reference to quantitative forecasts	2.8 CPI	1995-2006
Sweden	1993	Fully-fledged	Monetary policy report, three times a year; www.riksbank.com	Conditional on unchanged policy rates	1.5 CPI	1994-2006
Thailand	2000	Fully-fledged	Four times a year; www.bot.or.th	Conditional on unchanged policy rates	2.3 CPI and "core" inflation	2000-2006

Source: National central bank websites; Carare and Stone (2006); *World Economic Outlook*.
[1] See Stone (2003) for definitions.
[2] The average for 2001–05.

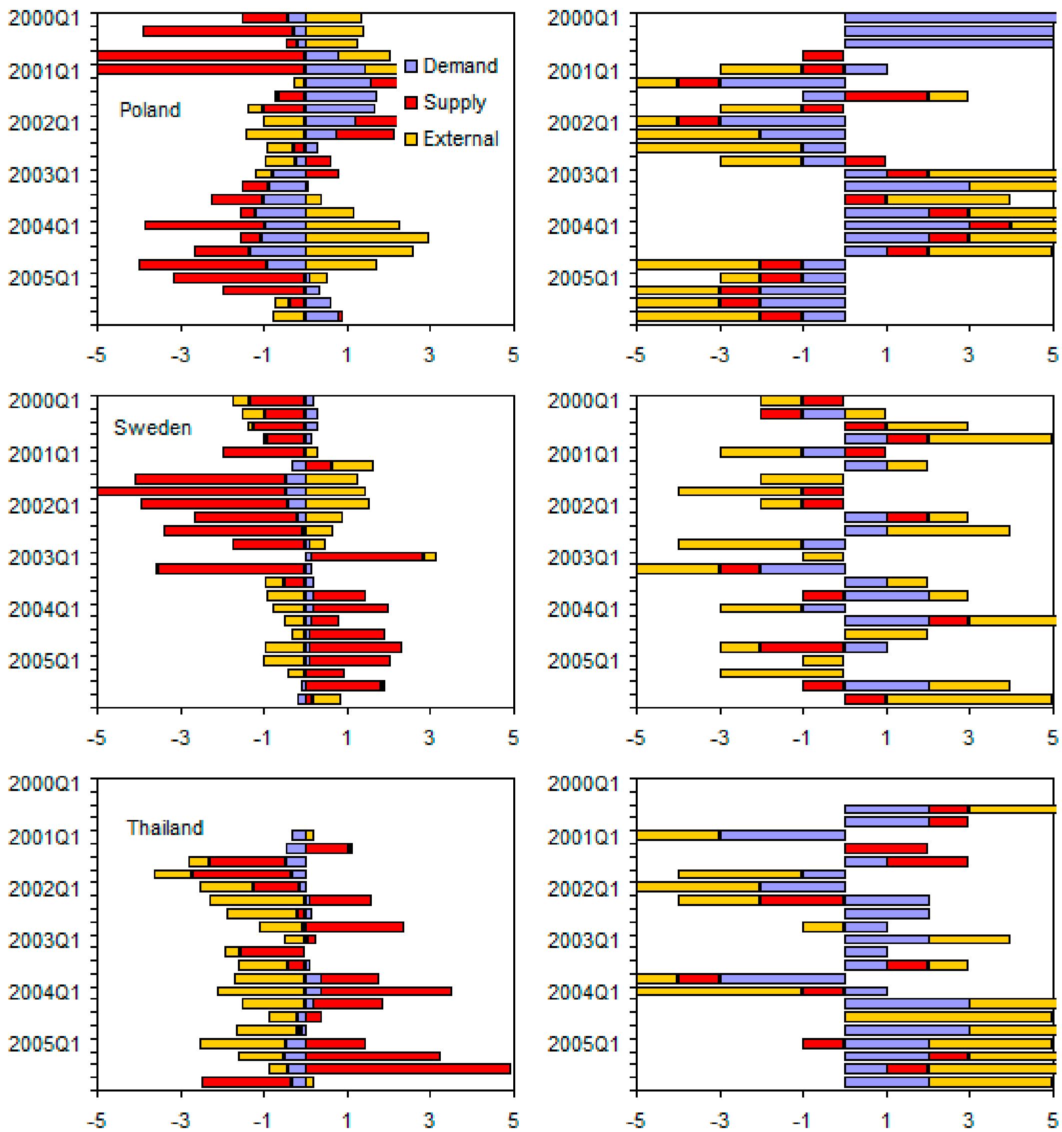
Figure A1.1. Model-Identified and Reported Inflation Factors (Continued)



Source: Authors' calculations.

Notes: Model-identified and reported factors for each country are on the left and right, respectively.

Figure A1.1. Model-Identified and Reported Inflation Factors (Concluded)



Source: Authors' calculations.

Notes: Model-identified and reported factors for each country are on the left and right, respectively.

The Model and Its Calibration

Aggregate demand (IS) and supply (Phillips curve) equations take the following form:

$$\hat{y} = a_1 \hat{y}_{t-1} - a_2 \hat{r}_t + a_3 \hat{z}_t + a_4 \hat{y}_t^* + \varepsilon_t^y \tag{1}$$

$$\pi_t = b_1 \pi_{t+1}^e + (1-b_1)\pi_{t-1} + b_2 \hat{z}_t + b_3 \hat{y}_t + \varepsilon_t^\pi \tag{2}$$

where $\hat{y}_t$, $\hat{r}_t$, $\hat{z}_t$, and $\hat{y}_t^*$ represent the deviations of actual output, the real interest rate, the real exchange rate, and foreign output from their respective noninflationary (natural) levels, π_t and π_{t+1}^e represent domestic and expected (model-consistent) inflation. Shocks are denoted by ε^i. The variables are in logs, except for interest rates.

The uncovered interest rate parity equation takes the form:

$$s_t = s_{t+1}^E + (i_t^* - i_t + prem_t)/4 + \varepsilon_t^S \tag{4}$$

where s_t is the nominal exchange rate at time *t*, s_{t+1}^E is its expectations, i_t^* is the foreign nominal short-term interest rate, and *prem* is the premium required by investors for holding domestic securities. The interest rate differential between domestic and foreign short-term nominal interest rates $i_t - i_t^*$ is quoted in annual terms. In contrast to inflation expectations, the term s_{t+1}^E does not represent model consistent expectations of the exchange rate, but instead it is derived as a weighed average of model consistent expectations and backward looking element based on the relative version of the purchasing power parity framework (5):

$$s_{t+1}^E = c_1 s_{t+1}^e + (1-c_1)(s_{t-1} + 2/4(\pi_t^T - \bar{\pi}_t^* + \Delta \bar{z}_t)) \tag{3}$$

where s_{t+1}^e is model consistent expectations of the nominal exchange rate, $\bar{\pi}_t^*$ is foreign long-run inflation defined as the inflation target, and $\Delta \bar{z}_t$ is the change in the trend real exchange rate. This specification was proposed by Berg, Karam and Laxton (2006) and its advantages and shortcomings were discussed by Beneš, Hurník and Vávra (2008). This specification avoids the jittery exchange rate behavior observed under the pure version of the uncovered interest rate parity equation.

Finally, the forward-looking policy rule is as follows:

$$i_t = d_1 i_{t-1} + (1-d_1)(\bar{r}_t + \pi_{t+1}^e + d_2(\pi_{t+4}^e - \pi_{t+4}^T) + d_3 \hat{y}_t) + \varepsilon_t^i \tag{4}$$

where i_t represents the policy (and market) short-term rate, $\bar{r}_t$ is the trend short-term real interest rate, and π_t^T is the inflation target.

The model further contains the following equations and identities:

$$r_t = i_t - \pi^e_{t+1}$$

$$\hat{r}_t = r_t - \bar{r}_t$$

$$\bar{r}_t = \bar{r}^*_t - \Delta\bar{z}_t + prem_t$$

$$\Delta z_t = \Delta s_t + \pi_t - \pi^*_t$$

$$\hat{z}_t = z_t - \bar{z}_t$$

$$i^*_t = \bar{r}^*_t + \pi^{e*}_{t+1}$$

$$z_t = z_{t-1} + \Delta z_t / 4$$

$$\bar{z}_t = \bar{z}_{t-1} + \Delta\bar{z}_t / 4 ,$$

where r_t is the short-term real interest rate, $\bar{r}^*_t$ is the foreign trend real interest rate, and Δz_t is the change in the real exchange rate. In our notation, bars denote potentially exogenous trend values of model variables with the property that $\lim_{t\to\infty} \bar{x}_t = \lim_{t\to\infty} x_{t,} \forall x$. For instance, $\bar{z}$ is an exogenous trend in the real exchange rate, implying that $\bar{z} = z$ in the steady state.

The calibration of model parameters is summarized in Table A2.1. The parameters *a*, *b*, *c*, and *d* correspond to the aggregate demand, supply, uncovered interest parity condition, and the policy rule, respectively. With the exception of Sweden and the eurozone, the parameter values differ from those for Canada to better reflect the stylized facts of emerging marking economies.

We note, first, that the effect of the real exchange rate on the output gap (parameter a_3) is stronger in emerging economies than that in Sweden (or Canada) and may even exceed the strength of the real interest rate effect on output (a_2). This reflects a much stronger exchange rate channel of monetary policy in emerging market economies, whose underdeveloped financial markets and high financial dollarization (euroization) tend to reduce the relative strength of the interest rate channel. Second, the output gap in emerging economies is more dependent on external demand than that in industrial countries (parameters a_4). Third, the exchange rate pass-through, b_2, is stronger and faster in emerging economies. Fourth, the slope of the Phillips curve, b_3, appears to be higher in emerging economies, reflecting the relatively low costs of disinflation. The eurozone calibration exhibits its closed-economy features: parameters a_3, a_4, and especially b_2 are low compared to the sample small open economies, while the exchange rate is more persistent (c_1).

Table A2.1. Parameter Calibration

Parameter	Chile	Czech Republic	Eurozone	Hungary	Poland	Sweden	Thailand	Canada[1]	All-purpose[1]
a_1	0.8	0.8	0.7	0.7	0.7	0.5	0.8	0.85	0.50–0.90
a_2	0.2	0.2	0.15	0.15	0.2	0.1	0.2	0.10	-
a_3	0.4	0.1	0.05	0.15	0.1	0.05	0.6	0.05	-
a_4	0.6	0.6	0.2	0.5	0.4	0.4	0.3	0.25	-
b_1	0.7	0.7	0.8	0.7	0.7	0.8	0.7	0.80	> 0.50
b_2	0.2	0.2	0.01	0.15	0.1	0.05	0.4	0.10	-
b_3	0.7	0.2	0.1	0.15	0.2	0.15	0.6	0.30	-
c_1	0.5	0.5	0.6	0.5	0.5	0.5	0.5	-	-
d_1	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.50	0.50–1.00
d_2	1.5	2.0	1.5	1.0	2.0	1.5	1.5	2.00	-
d_3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.50	-

[1] See Berg, Karam and Laxton (2006).

Annex III

Tests of Predictive Power

Table A3.1. Mean Square Error of In-Sample Inflation Forecasts

Forecast period	Chile	Czech Republic	Eurozone	Hungary	Poland	Sweden	Thailand
T+1	0.77	0.80	0.28	1.39	0.79	0.73	1.65
T+2	1.70	1.83	0.46	3.02	1.50	1.21	2.20
T+3	2.70	2.79	0.89	3.52	2.94	1.79	2.76
T+4	2.69	3.13	0.75	3.95	3.71	1.72	2.38
T+5	2.19	3.49	0.65	4.36	4.24	1.28	1.45
T+6	1.72	3.54	0.65	4.48	4.71	0.81	1.39

Source: Own calculations

Figure A3.1. In-Sample Inflation Forecasts

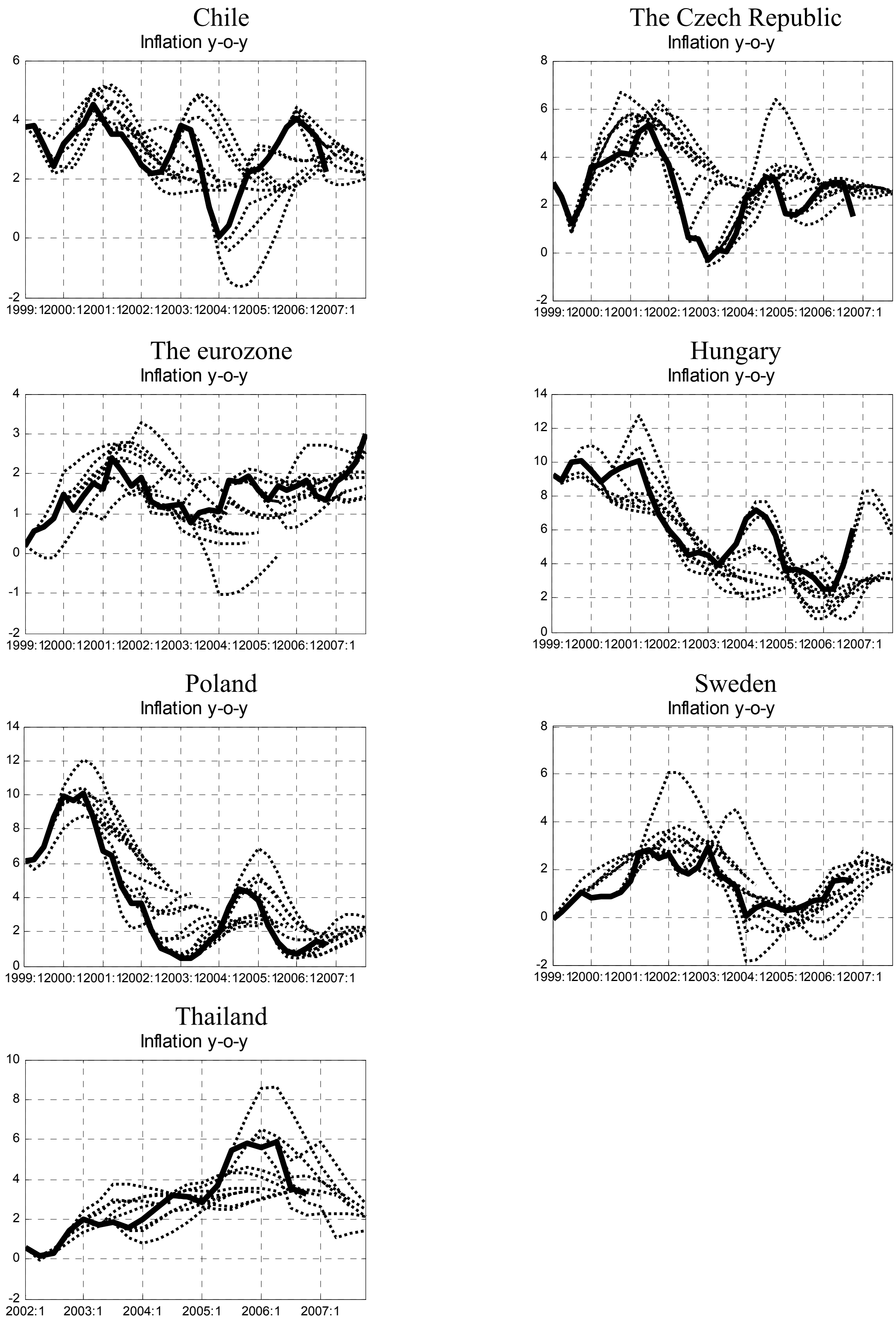
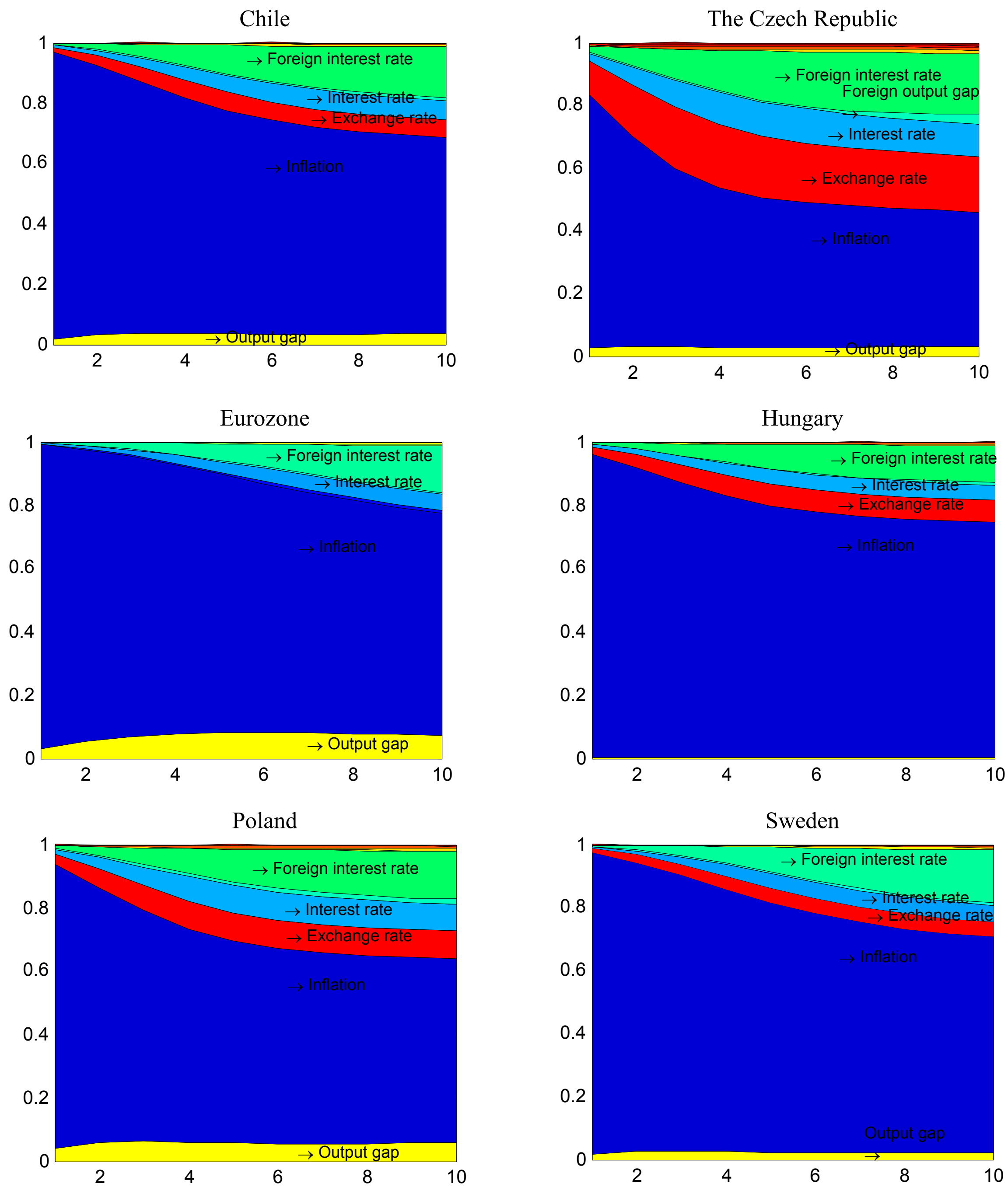
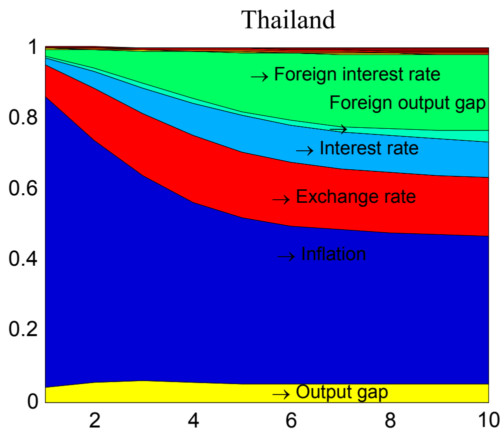


Figure A3.2 Model-Implied Forecast Error Variance Decomposition for Inflation




Thailand
1
0.8
0.6
0.4
0.2
0
2
4
6
8
10
→ Foreign interest rate
Foreign output gap
→
→ Interest rate
→ Exchange rate
→ Inflation
→ Output gap

Annex IV

Table A4.1 Correlations of Model-Based and Reported Inflation Factors

			Aggregate demand	Aggregate supply	Exchange rate
Chile	Contemporaneous	2000-2005	**0.82**	**0.33**	-0.26
		2000-2002	**0.46**	**0.56**	-0.19
		2002-2005	**0.87**	**0.31**	0.01
	2-quarter leads	2000-2005	**0.60**	**0.66**	0.00
		2000-2002	**0.58**	**0.67**	-0.09
		2002-2005	**0.59**	**0.64**	0.12
Czech Republic	Contemporaneous	2000-2005	-0.13	**0.42**	0.05
		2000-2002	-0.36	**0.36**	-0.62
		2002-2005	**0.21**	**0.57**	0.08
	2-quarter leads	2000-2005	0.16	-0.23	**0.41**
		2000-2002	-0.50	0.24	**0.25**
		2002-2005	**0.59**	-0.48	**0.41**
Hungary	Contemporaneous	2001-2005	**0.35**	**0.22**	0.16
		2002-2005	**0.40**	0.12	0.15
	2-quarter leads	2001-2005	**0.22**	-0.09	**0.23**
		2002-2005	**0.29**	-0.10	**0.31**
Poland	Contemporaneous	2000-2005	-0.54	-0.28	**0.31**
		2000-2002	-0.39	-0.13	**0.15**
		2002-2005	-0.59	-0.27	**0.41**
	2-quarter leads	2000-2005	-0.44	-0.56	**0.56**
		2000-2002	-0.13	-0.63	**0.28**
		2002-2005	-0.49	-0.47	**0.74**
Sweden	Contemporaneous	2000-2005	**0.26**	**0.31**	**0.14**
		2000-2002	**0.77**	**0.29**	-0.07
		2002-2005	-0.21	**0.27**	**0.23**
	2-quarter leads	2000-2005	**0.24**	0.17	0.21
		2000-2002	**0.58**	0.01	**0.44**
		2002-2005	-0.06	0.10	0.05
Thailand	Contemporaneous	2000-2005	-0.10	0.17	**0.64**
		2000-2002	0.00	-0.23	0.16
		2002-2005	-0.40	0.06	**0.62**
	2-quarter leads	2000-2005	-0.26	**0.20**	0.16
		2000-2002	0.13	**0.36**	0.16
		2002-2005	-0.57	0.07	0.08
Eurozone	Contemporaneous	2000-2005	**0.14**	**0.45**	-0.34
		2000-2002	**0.81**	**0.80**	-0.54
		2002-2005	**0.23**	**0.35**	-0.40
	2-quarter leads	2000-2005	**0.13**	**0.26**	-0.04
		2000-2002	**0.66**	**0.35**	-0.63
		2002-2005	**0.30**	**0.38**	-0.05

Notes: Correlation coefficients in bold are significant at 20 percent.