CHAPTER 6

INFLATION FORECASTS ERRORS IN THE CZECH REPUBLIC: EVIDENCE FROM A PANEL OF INSTITUTIONS

JAN BABECKÝ
JIŘÍ PODPIERA

1. INTRODUCTION

How is the CNB accurate in inflation forecasting? Why are there forecast errors, and are they systematic? Could, for example, forecast errors be at least partially explained by exchange rate shocks? Do professional forecasters learn from their past forecast errors? This analysis offers the first and to our knowledge unique feedback on forecast error decomposition and the accuracy of the past inflation forecasts produced by the Czech National Bank (CNB) in comparison with a number of alternative forecasting institutions in the Czech Republic, which report in the framework of the Macroeconomic Colloquia[1].

The assessment of inflation forecasts has traditionally been in the centre of attention of central banks (see, for example, McNees, 1992; Croushore, 1998; Canova, 2002; Espasa *et al*., 2002; McCaw and Ranchhod, 2002). It also represents the subject of a broader academic and policy debate (Granger, 1996; Diebold and Mariano, 2002; Valev and Carlson, 2003; Keereman, 1999). While the literature generally gives a detailed analysis of the macro- and micro-economic factors, which can affect the quality of inflation forecasts, there are very few studies that systematically analyse the forecast error decomposition.

Reliable central bank inflation forecasts are essential for the implementation and communication of monetary policy, serving as an anchor for future inflation expectations (Bernanke and Woodford, 1997). Inflation forecasts are also produced by a number of national and international institutions. Therefore, a comparison of professional forecasters is a compelling way of how to assess the central bank forecast performance since forecasting institutions face similar uncertainties country-wise.

The evidence for the particular approach of comparing a central bank against other professional forecasters is rather limited. For example, the analysis by Gavin and Mandal (2003) suggests that during the late 1990s the Federal Reserve's staff inflation forecasts outperformed those produced by the private sector. Giavazzi and Mishkin (2006) point out that errors in inflation forecasts by the Swedish central bank during 1997–2005 did not significantly differ from the forecast errors of other institutions. Another angle is to look at forecasting methods, types of forecasts (e.g. conditional versus unconditional), frequency of updates and institutional and other aspects. Berger *et al*. (2006) argue that geographical and country-specific factors could contribute to systematic errors in the European Central Bank's forecasts. The importance of these factors as applied to inflation forecasts remains so far unexplored.

Quality of forecasts is an important criterion for judging a forecaster's credibility, but it is not the only one. Another central criterion is how influential the central bank's forecasts are. In his recent original study, Fujiwara (2005) shows that the Bank of Japan's economic forecasts considerably affect the forecasts made by other institutions, while the reverse direction of causality is insignificant. This finding has important implications for the issue of monetary policy effectiveness and the leading role of the central bank[2].

Our analysis is based on comparisons of errors in inflation forecasts performed by institutions, which systematically forecasted inflation in the Czech Republic during 2002–2007. They are in total 16 institutions, including the Czech National Bank.

[1] Biannual framework of collecting macroeconomic forecasts from institutions residing in the Czech Republic and forecasting the Czech economy, administrated by the Ministry of Finance of the Czech Republic.
[2] We leave the assessment of how influential the CNB macroeconomic forecasts are for future research.

We examine how successful the CNB is compared to other institutions in terms of unbiasedness of forecasts and forecast standard errors. First, we estimate fixed effects in a panel of institutions; this method roughly corresponds to the simple averaging of both relative and absolute forecast errors. Second, we estimate another fixed effects specification, conditional on exchange rate forecast errors (as the main variable influencing inflation forecasts) and on past inflation forecast errors up to the fourth lag (equivalently two years given the bi-annual data).

A particular value added of our an analysis is – if the hypothesis of long series of asymmetric shocks is valid – that such shocks should be common to all institutions, and therefore the relative success of forecasts, i.e. forecast unbiasendess, should be conditional on such socks (e.g. errors in exchange rate forecasts).

Our results indicate that simple averages of forecast errors are statistically biased and have statistically significant standard errors for all institutions. However, controlling for the exchange rate forecast errors (which turn out to be significant determinant of common shocks – that is supporting the hypothesis of a long series of asymmetric exchange rate shocks) and considering learning from the past inflation forecast errors, we find that the majority of institutions (13 out of 16) are characterised by unbiased inflation forecasts. In other words, should such institutions be able to correctly foresee the CZK exchange rate, their inflation forecasts would not be biased. Moreover, the dispersion of inflation forecasts across institutions decreases significantly following the subtraction of exchange rate forecasts errors from inflation forecast errors.

The example of the CNB, which records a marginally significant (at the 10% significance level) systematic error in inflation forecasts even upon controlling for the exchange rate forecasts (the CNB forecasts higher than in reality inflation), would confirm (although only to a marginal extent) the hypothesis of the skewed sight. However, this result does not necessarily indicate a bias in the CNB prognostic apparatus. Indeed, the result may be due to an existence of other variables such as food and energy prices which the CNB forecasted with a higher error compared to other institutions.

The rest of the paper is organised as follows: Section 2 describes methodology of the analysis of inflation forecast errors, while section 3 brings the estimation results. Section 4 provides some concluding remarks.

2. METHODOLOGY

Our analysis is structured into two steps. In the first step, we perform a simple evaluation of inflation forecast errors by the individual institutions in terms of the average relative forecast error (Average Relative Forecast Error, ARFE) and the average absolute forecast error (Average Absolute Forecast Error, AAFE). While the ARFE indicates the direction of the forecast bias (over- or under-prediction), the AAFE shows the average deviation of the forecast from the outturn.

In the second step, we attempt to identify factors, which cause forecast errors. One of the most appealing hypotheses for an existence of a systematic error in inflation forecasts is the market's limited ability to predict exchange rate developments. That is, the hypothesis that – due to a limited forecasters' ability to predict the exchange rate – a systematic error occurs in inflation forecasts. Therefore, we evaluate the conditional (on exchange rate forecast error and on past inflation errors) average relative inflation forecast error (CARFE) and the conditional average absolute forecast error (CAAFE).

2.1 Model

In order to account for cross-correlations in the forecasts of various institutions (forecasts produced by institutions are not strictly mutually independent), we suggest applying the following fixed effects model specification:

$$\begin{aligned} RFE_{i,t} &= c_i + \varepsilon_{i,t} \\ AFE_{i,t} &= d_i + \omega_{i,t} \end{aligned}, \qquad (1)$$

where $RFE_{i,t}$ and $AFE_{i,t}$ are, respectively, the relative and the absolute forecast errors of institution i at time t *(one year and two year ahead forecasts)*[3], further c_i and d_i denote the fixed effects that represent the *ARFE* and *AAFE*, correspondingly. Equation (1) represents the first step of the analysis, where *RFE* and *AFE* are regressed on forecasting institution's specific constant. In the second step, the following explanatory variables are added: the forecaster's specific exchange rate forecast error, past inflation forecast errors, and the dummy variable equal to one for the second sample period 2004–2007, zero otherwise, which leads to the following specification:

$$\begin{aligned} RFE_{i,t} &= e_i + \beta RFE\_ER_{i,t} + \sum_{k=1}^{4} \delta_k RFE_{i,t-k} + d_{04\_07} + \xi_{i,t} \\ AFE_i &= f_i + \gamma AFE\_ER_{i,t} + \sum_{k=1}^{4} \theta_k AFE_{i,t-k} + d_{04\_07} + \nu_{i,t} \end{aligned}, \qquad (2)$$

where $RFE\_ER_{i,t}$ and $AFE\_ER_{i,t}$ represent, respectively, the relative and the absolute forecast error of the exchange rate forecast of institution i at time t. Coefficients β and γ stand for the forecaster institution's common elasticity of inflation forecast errors with respect to the exchange rate forecast error. These parameters speak for the consistency of the forecasting tools on average across forecasters and for the magnitude of the effect of exchange rate forecast errors on inflation forecast errors.

Next, parameters δ and θ represent the past dependence of current forecast error on its own past values; the lag length k is set to 4 periods, which corresponds to a two-year delay until forecasters can realise in full and learn from their errors. Then, d_{04_07} is the time dummy equal to one for 2004–2007, capturing the systematic difference between the two defined forecasting periods (see below).

Finally, the parameters e_i and f_i in (2) represent the *CARFE* and *CAAFE*, respectively. By the letters $\varepsilon_{i,t}$, $\omega_{i,t}$, $\xi_{i,t}$, *and* $\upsilon_{i,t}$ we denote the forecast disturbances, with zero mean and constant variance.

2.2 Data

The experience of the Czech National Bank with inflation targeting policy dates between 1998 and 2007. The sample can be, however, divided into three distinct sub-periods. The first period 1998–2002 can be characterised as the introductory period with simple forecasting framework and

[3] The analysis combines forecasts produced at a given year for the current and next years. Since information on forecasts is collected twice a year, forecasts produced in the second part of the year actually do not represent forecasts for one full year in ahead; they are rather forecasts covering the current year (half-year ahead forecasts) and forecasts for one and a half years ahead. The average forecasting horizon is thus closer to the period of one year, rather than to the period of two years in advance – which corresponds to the horizon of the CNB's monetary policy.

conditional inflation forecasts (i.e. forecasted inflation is conditional on the path of the interest rate). The second period, 2002–2004, was a phase of an upgrade of forecasting methods – introduction of the quarterly prediction model, QPM, in 2002 – using which the staff produced unconditional inflation forecasts. And finally, the last period 2004–2007 is a routine period in which the extensive experience with this framework was collected, albeit minor changes in the model were implemented (the inclusion of the labour market block or a switch to the Euro Area Czech effective indicators away from the German ones, but the reaction function calibration, for instance, remained unchanged throughout the entire period since early 2003).

In our analysis we focus on the period of a standard forecasting framework 2002–2007 at the Czech National Bank and collect unconditional forecasts produced by all institutions continuously reporting to the Macroeconomic Colloquia over 2002–2007 twice a year[4]. A nice feature of the Macroeconomic Colloquia is that institutions are asked to report their forecasts on the same day, which minimises potential causality effects between forecasters. Data thus comprises 24 observations per institution (inflation and exchange rate forecasts for current and following year). For comparison, a similar study for the Bank of England uses 32 observations; see Bank of England Inflation Report (2003).

3. RESULTS

Table 1 shows the results for equation (1). In particular, it appears that all 16 reporting institutions produce upward-biased forecasts during 2002–2007; in other words, forecasted inflation is significantly higher than actual inflation (by 0.675 pp. for the Colloquia average). While the CNB and the Ministry of Finance (MoF CR) belong to the top-three most accurate forecasters in terms of the ARFE (left column), average deviation of forecasted inflation from the outturn becomes quite substantial in case of the CNB (right column). Notice that this ranking is rather indicative. In statistical terms, the difference between the best and the worst forecaster is not statistically significant. Also, one can see (as expected) that fixed effects alone do not satisfactory explain the forecast errors – the regression's R^2 are close to zero.

Table 2 presents the results for conditional forecast errors. The exchange rate (or more precisely, difference between forecasted and actual CZK/EUR nominal exchange rate changes) and lagged inflation forecast errors turn out to be significant determinants of contemporaneous inflation forecast errors, yielding R^2 of 0.46 for the relative and 0.61 for the absolute conditional forecast errors. Negative and significant coefficient on the exchange rate means that forecasters did not expect the CZK/EUR appreciation. Conditional on the exchange rate and the lagged inflation forecast errors, there is practically no bias in inflation forecasts except three institutions, the CNB being on the margin of significance. From the view point of the conditional absolute forecast errors, the conditional average absolute inflation forecast errors become insignificant for the majority of institutions, with the CNB being marginally significant.

[4] Changes in the money market 3M Pribor yield curve between the forecasts reflect revisions of such forecasts and monetary policy reaction. Podpiera (2008) shows that the 3M Pribor market-implied rates in the horizon of one year in fact coincide with the trajectory of the CNB-model interest rates. Therefore, we assume that the expected development of the CNB and market interest rates does not give rise to inconsistencies in inflation forecasts.

Table 1: Average forecast errors – relative (left) and absolute (right) – Eq. (1) estimated over 2002–2007

	Dependent variable: *RFE*				Dependent variable: *AFE*		
	Method: Pooled Least Squares				Method: Pooled Least Squares		
	Observations: 18				Observations: 18		
	Institutions: 16				Institutions: 16		
	Total observations: 262				Total observations: 262		
	Variable	Coef.	Std. Error		Variable	Coef.	Std. Error
1	ABN-AMRO	0.450*	(0.260)	1	**MoF CR**	0.653***	(0.251)
2	**MoF CR**	0.573**	(0.268)	2	Živnobanka	0.682***	(0.243)
3	**CNB**	0.614**	(0.245)	3	Volksbank CZ	0.691***	(0.235)
4	Živnobanka	0.626**	(0.260)	4	**Colloquia_average**	0.723***	(0.229)
5	Volksbank CZ	0.632**	(0.252)	5	Patria-Finance	0.736***	(0.229)
6	Komerční banka	0.644**	(0.260)	6	ČSOB	0.739***	(0.229)
7	Patria-Finance	0.647***	(0.245)	7	HVB	0.750***	(0.229)
8	**Colloquia_average**	0.675***	(0.245)	8	Česká spořitelna	0.756***	(0.229)
9	Česká spořitelna	0.694***	(0.245)	9	WOOD	0.767***	(0.229)
10	ČSOB	0.712***	(0.245)	10	Komerční banka	0.781***	(0.243)
11	HVB	0.717***	(0.245)	11	**CNB**	0.797***	(0.229)
12	WOOD	0.767***	(0.245)	12	ABN-AMRO	0.813***	(0.243)
13	Liberální institut	0.783***	(0.245)	13	Liberální institut	0.839***	(0.229)
14	Citibank	0.843***	(0.278)	14	Citibank	0.900***	(0.259)
15	Newton	0.875***	(0.278)	15	Newton	1.018***	(0.259)
16	Raiffeisen	0.975***	(0.329)	16	Raiffeisen	1.045***	(0.307)
	R^2		0.012		R^2		0.010
	Adjusted R^2		-0.048		Adjusted R^2		-0.050
	F-statistic		0.205		F-statistic		0.174
	Prob(F-statistic)		0.999		Prob(F-statistic)		1.000
	Durbin-Watson stat		1.818		Durbin-Watson stat		1.953

*Notes: ***, ** and * denote the statistically significant parameters at the 1%, 5% and 10% levels.*

Estimated variables – the relative inflation forecast error (RFE) and the absolute inflation forecast error (AFE) –are regressed on institution-specific constant terms.

Learning-by-doing: both relative and absolute forecast errors exhibit similar time dependence: forecast errors tend to be persistent at the horizon of up to one year (one and two lags correspondingly), due to the fact that forecasters can not realise and learn from their past forecast errors fully as they do not know the entire reality yet. However, at the horizon between one and two years (three to four lags) a reversion occurs; institutions learn from their past errors (they already know the full set of actual realisations), which results in lower current forecast errors.

Next, in order to assess whether there is a change in forecasting accuracy over time, a dummy is added equal to 1 for the period 2004–2007. Negative and significant values of time dummy imply that average deviation of the forecasting errors decreases; this is the case of the CAAFE. For the CARFE, the time dummy is insignificant, signalling that forecast biasedness did not improve over time on average (but the majority of institutions produced unbiased forecasts – after controlling for learning and exchange rate forecast errors).

Table 2: Conditional average forecast errors – relative (left) and absolute (right) – Eq. (2) estimated over 2002–2007

	Dependent variable: *RFE*				Dependent variable: *AFE*		
	Method: Pooled Least Squares				Method: Pooled Least Squares		
	Observations: 17				Observations: 17		
	Institutions: 16				Institutions: 16		
	Total observations: 213				Total observations: 213		
	Variable	Coef.	Std. Error		Variable	Coef.	Std. Error
		-					
	RFE_ER	0.089***	(0.024)		AFE_ER	0.167***	(0.022)
	D_04_07	0.049	(0.244)		D_04_07	-0.414**	(0.209)
	RFE(-1)	0.192***	(0.070)		AFE(-1)	0.231***	(0.059)
	RFE(-2)	0.432***	(0.073)		AFE(-2)	0.312***	(0.065)
		-				-	
	RFE(-3)	0.231***	(0.079)		AFE(-3)	0.238***	(0.072)
	RFE(-4)	-0.139*	(0.077)		AFE(-4)	-0.128*	(0.075)
1	ABN-AMRO	0.269	(0.302)	1	ABN-AMRO	0.289	(0.290)
2	Komerční banka	0.270	(0.379)	2	WOOD	0.311	(0.308)
3	Raiffeisen	0.327	(0.492)	3	Komerční banka	0.369	(0.339)
4	WOOD	0.376	(0.362)	4	Volksbank CZ	0.394	(0.278)
5	Patria-Finance	0.419	(0.332)	5	Patria-Finance	0.426	(0.296)
6	HVB	0.435	(0.355)	6	Živnobanka	0.439	(0.298)
7	Volksbank CZ	0.441	(0.316)	7	HVB	0.451	(0.306)
8	Živnobanka	0.475	(0.343)	8	Raiffeisen	0.465	(0.414)
9	**Colloquia_average**	0.488	(0.332)	9	**Colloquia_average**	0.491*	(0.292)
10	Česká spořitelna	0.509	(0.329)	10	Liberální institut	0.499	(0.304)
11	**MoF CR**	0.509	(0.389)	11	Česká spořitelna	0.508*	(0.291)
12	ČSOB	0.515	(0.331)	12	**MoF CR**	0.522	(0.339)
13	**CNB**	0.537*	(0.323)	13	ČSOB	0.532*	(0.290)
14	Newton	0.553	(0.357)	14	**CNB**	0.555*	(0.300)
15	Citibank	0.722*	(0.390)	15	Newton	0.587*	(0.310)
16	Liberální institut	0.744**	(0.352)	16	Citibank	0.710**	(0.344)
	R^2		0.463		R^2		0.610
	Adjusted R^2		0.403		Adjusted R^2		0.567
	F-statistic		7.826		F-statistic		14.244
	Prob(F-statistic)		0.000		Prob(F-statistic)		0.000
	Durbin-Watson stat		2.371		Durbin-Watson stat		2.237

*Notes: ***, ** and ** denote the statistically significant parameters at the 1%, 5% and 10% levels.*

Estimated variables – the relative inflation forecast error (RFE) and the absolute inflation forecast error (AFE) –are regressed on exchange rate forecast errors, the dummy variable taking the value of 1 for the period 2004–2007, past inflation forecast errors and institution-specific constant terms.

Comparing inflation forecasts of the Ministry of Finance (one of the most successful inflation forecasters) and the CNB, one can notice that both institutions are quite similar (have close ranking) in terms of the CARFE, CAAFE and ARFE. However the difference between these two institutions is pronounced in the case of the AAFE, the Ministry of Finance being characterised by lower average absolute forecast error compared to the CNB. Moreover, the Ministry of Finance's inflation

forecasts are unbiased, while the CNB's forecasts are marginally biased (at the 10% significance level).

Furthermore, comparing the CNB with the Colloquia Average in terms of the conditional forecast errors, the results suggest that the Colloquia Average is unbiased while the CNB turns out to be marginally biased towards inflation over prediction. In terms of the size of the average deviation, the CNB appears to be similar to the Colloquia Average (both exhibit marginally significant average deviation). Nevertheless, given the fact that after controlling for errors in exchange rate forecasts (see CARFE, Table 2), the majority of the institutions produce unbiased forecasts (contrary to the CNB), one can argue that the CNB was not a leader in inflation forecasts during 2002–2007. This conclusion is further confirmed by the results of the conditional average absolute forecast error (CAAFE).

So far, we have interpreted the results in terms of the significance of the forecast errors compared to zero (bias or size of average deviation). In terms of the relative significance of the average forecast errors across forecasters, we conclude that differences in performance of the majority (practically all) of forecasters can not be mutually distinguished on conventional statistical significance levels.

4. CONCLUDING REMARKS

In this paper we performed a comparison of the CNB's accuracy of inflation forecasts with other institutions predicting inflation in the Czech Republic. We used a unique data set of the Macroeconomic colloquia managed by the Czech Ministry of Finance and evaluated the average relative and average absolute forecast errors.

The results suggest that while it is not possible to statistically distinguish among forecasters and the unconditional average forecast errors are significant for all forecasters, some forecasters do perform better in terms of unbiasedness and average deviation of conditional (on exchange rate forecast error and learning) forecasts than others. In particular, the CNB performs slightly worse than majority of professional forecasters by exhibiting a marginally significant bias and statistically significant average deviation in inflation forecasts. So called "herd behaviour" (see Giavazzi and Mishkin, 2006) could be one possible reason making difficult a differentiation of forecast accuracy among the institutions.

REFERENCES

BANK OF ENGLAND (2003): Inflation Report August 2003.

BERGER, H., M. EHRMANN, AND M. FRATZSCHER (2006): "Forecasting ECB Monetary Policy: Accuracy Is (Still) a Matter of Geography," IMF Working Paper, 06/41.

BERNANKE, B. S. AND M. WOODFORD (1997): "Inflation Forecasts and Monetary Policy," *Journal of Money, Credit and Banking*, 29(4), pp. 653–684.

CANOVA, F. (2002): "G-7 Inflation Forecasts," ECB Working Paper Series, No. 151.

CROUSHORE, D. (1998): "Evaluating Inflation Forecasts," Federal Reserve Bank of Philadelphia Working Papers, No. 98–14.

DIEBOLD, F. X. AND R. S. MARIANO (2002): "Comparing Predictive Accuracy," *Journal of Business and Economic Statistics*, 20(1), pp. 134–144.

ESPASA, A., E. SENRA, AND R. ALBACETE (2002): "Forecasting Inflation in the European Monetary Union: A Disaggregated Approach by Countries and by Sectors," *European Journal of Finance*, 8(4), pp. 402–421.

FILDES, R. AND H. STEKLER (2002): "The state of macroeconomic forecasting," *Journal of Macroeconomics*, 24(4), pp. 435–468.

FUJIWARA, I. (2005): "Is the Central Bank's Publication of Economic Forecasts Influential?" *Economics Letters*, 89(3), pp. 255–261.

GAVIN, W. T. AND R. J. MANDAL (2003): "Evaluating FOMC Forecasts," *International Journal of Forecasting*, 19(4), pp. 655–667.

GIAVAZZI, F. AND F. S. MISHKIN (2006): "An Evaluation of Swedish Monetary Policy between 1995 and 2005," Reports from the Riksdag 2006/07: RFR 1, Committee on Finance.

GRANGER, C.W. J. (1996): "Can We Improve the Perceived Quality of Economic Forecasts?" *Journal of Applied Econometrics*, 11(5), pp. 455–473.

KEEREMAN, F. (1999): "The Track Record of the Commission Forecasts," European Economy – Economic Papers, No. 137, Commission of the EC, Directorate-General for Economic and Financial Affairs (DG ECFIN).

MCCAW, S. AND S. RANCHHOD (2002): "The Reserve Bank's Forecasting Performance," Reserve Bank of New Zealand Bulletin, 65, pp. 5–23.

MCNEES, S. K. (1992): "How Large are Economic Forecast Errors?" *New England Economic Review*, Federal Reserve Bank of Boston, July, pp. 25–42.

PODPIERA J. (2008): "Policy Rate Inertia Reconsidered: Evidence from Endogenous Interest Rate Trajectory," *Economics Letters*, 100(2), p. 238–240.

VALEV, N. T. AND J. A. CARLSON (2003): "Sources of Dispersion in Consumer Inflation Forecasts," *Applied Economic Letters*, 10(2), pp. 77–81.