Central Bank Forecasts as a Coordination Device: Evidence from the Czech Republic

Jan Filáček*, Branislav Saxa**

Abstract Do private analysts coordinate their forecasts via central bank forecasts? In this paper, we examine private and central bank forecasts for the Czech Republic. The evolution of the standard deviation of private forecasts as well as the distance from the central bank's forecasts are used to study whether a coordination effect exists, how it is influenced by uncertainty, and the effects of changes in central bank communication. The results suggest that private analysts coordinate their forecasts for the interest rate and inflation, while no or limited evidence exists for the exchange rate and GDP growth.

Keywords Central bank, forecast, coordination
JEL classification E37, E47, E58, G14

1. Introduction

Central bank transparency has become one of the most prominent features of monetary policy-making over the last two decades. Central banks have enhanced their transparency in many respects. Publishing minutes and votes cast, describing the outlook for the economy and its risks, commenting on statistical releases and other disclosures have all become a part of a central banker's daily job. In this regard, the publication of central bank forecasts is of utmost importance.[1] These forecasts contain complex information about the central bank's assessment of the current state of the economy and its vision of future economic developments. This vision usually, and increasingly, includes the reaction of the central bank and sends an important signal to market participants on the future stance of monetary policy. Forecasts are also usually a benchmark against which the decision-making body evaluates risks and makes a final decision. In this paper we focus on another important aspect of publishing the central bank forecast—its coordination role for private agents' expectations and forecasts.

The expectations of financial market participants are very important for any central bank. If private expectations are broadly in line with central bank expectations, the

---

* Corresponding author. Czech National Bank, Monetary and Statistics Department, Na Příkopě 28, 11503 Prague 1, Czech Republic. Phone +420 224 413 726, Email: jan.filacek@cnb.cz.

** Czech National Bank, Monetary and Statistics Department, Na Příkopě 28, 11503 Prague 1, Czech Republic. Phone +420 224 413 468, Email: branislav.saxa@cnb.cz.

[1] The first central bank to publish its forecast was the Reserve Bank of New Zealand in 1985 (Reserve Bank of New Zealand 1985). Since then, the publication of central bank forecasts for inflation and real economic activity has become standard practice. Some central banks go further and also publish interest rate and exchange rate forecasts.

central bank has a check that its communication has been properly understood and that its vision has been conveyed properly to the financial markets. If, however, private expectations differ significantly from the central bank forecast, the vision of the central bank might have been communicated badly or might even have been disbelieved. In either case, central banks should be worried—if the financial market does not share the vision, then the vision is less likely to materialize. It is mainly for this purpose that the majority of central banks collect the expectations of private economists.

This paper expands on the existing literature in at least three respects. First, we look at the coordination problem from a closer perspective, analysing the responses of individual private forecasters to released central bank forecasts. Second, we do not only look at the dispersion of private forecasts, but also examine how distant private forecasts are from the central bank forecast. Third, we focus on the details of central bank forecast communication by taking into account the risk assessment as viewed by the board members and by inspecting the effects of communication improvements. Our results suggest that private analysts coordinate their forecasts for the interest rate and inflation, while there exists no or limited evidence for the exchange rate and GDP growth.

2. Literature review

There is an extensive literature covering the field of information asymmetry between a central bank and the public. Since the seminal paper of Kydland and Prescott (1977), which favoured symmetric information (policy rule) to asymmetric information (discretionary policy), many papers have dealt with the issue. Several different types of asymmetries in the information sets of a central bank and the public can be identified. Most attention has been paid to the asymmetry regarding central bank objectives and asymmetries regarding economic shocks hitting the economy.

A central bank forecast, if it includes description of central bank behaviour, contains information on both central bank objectives and economic shocks. Therefore, many papers use the disclosure of central bank forecasts as an illustrative example of how information asymmetry between a central bank and the public might be removed and what the economic effects of such a step would be. Unfortunately, the conclusions of these papers are rather ambiguous, and depend on the frameworks and assumptions used.

For example, Jensen (2002), using a New-Keynesian model with unobserved output, shows that publishing forecasts of current shocks on the one hand solves the credibility problem, but on the other distorts the stabilization policy of a central bank. Cukierman (2001) arrives at a similar conclusion in Neo-Keynesian and Neo-monetarist setups. However, Fukač (2006), in a New Keynesian framework with adaptive learning, finds that a central bank has a more difficult job in stabilizing an economy with heterogeneous expectations than in stabilizing an economy with homogeneous expectations. In Geraats (2001), the public observes neither economic shocks, nor the inflation target. In this framework, she finds that revealing the central bank forecast enhances the central bank's reputation, reduces the inflation bias and gives the central bank greater

flexibility to respond to shocks in the economy. The disclosure of future shocks in the New-Keynesian framework has been analysed, for example, by Eijffinger and Tesfaselassie (2007). The conclusion of their analysis is that the advance disclosure of future shocks does not improve wealth, but might impair the stabilization of inflation and output.

All the above literature assumed heterogeneity between central bank and private information, but private agents were assumed to share the same set of public information. Morris and Shin (2002) were the first to extend the analysis of revealing central bank information for heterogeneity among private agents. Each economic agent might differ in her information set and in her expectations. Allowing for different information sets or beliefs among the public gives an additional role to the release of central bank information: that of serving as a coordination device. Publishing forecasts might motivate market participants to coordinate their beliefs based on the central bank's forecast.

Morris and Shin (2002) show that if private agents coordinate their actions they tend to put more weight on the public signal than is justified by the level of its precision. Too much attention paid to public signals is harmful, because they crowd out private signals. Private agents lose incentives to gather their own information (make their own forecasts) and as a consequence, private expectations might diverge from the fundamentals.

In a response to Morris and Shin (2002), Svensson (2006) advocates greater transparency. He shows that more public signals enhance welfare within a reasonable range of model parameters.

Coordination can be motivated by the same factors as Bikhchandani and Sharma (2000) suggest in their overview of herd behaviour in financial markets. Market participants can rationally imitate the others, because the others might have some information not available to everybody. Compensation schemes can be set so that rewards are based on performance relative to the rest of the market or simply market participants might have a preference for conformity. Transparent communication from a central bank can potentially trigger herd behaviour with the central bank forecast being used as a coordination tool.

Given the opposing views on the welfare effects of publishing central bank forecasts, the results of empirical studies on coordination are highly relevant. Several empirical papers have been written on this issue.

Bauer et al. (2006) used cross-sectional data to decompose the forecast accuracy of U.S. financial market participants into two components: common errors that affect all forecasters, and idiosyncratic errors, which reflect the different views across the forecasters. They found that since the FOMC began to release statements accompanying changes in the monetary policy instrument in 1994, idiosyncratic shocks have been reduced, implying that the expectations of individual forecasters have become more synchronized. However, they did not find evidence that common errors have become smaller since 1994. They conclude that common errors seem to be associated with the business cycle and economic shocks. As such, they can hardly be improved by transparent monetary policy.

Ehrmann and Fratzscher (2007) empirically tested for the effects of the relative

accuracy of public and private signals on the efficiency of central bank communication. To proxy for this efficiency, the authors used two measures—a measure of the short-term predictability of central bank board decisions as well as a measure of medium-term predictability. The surprise component of interest rate decisions was used to proxy short-term predictability, with medium-term predictability being proxied by the dispersion of the private forecasts of interest rates. The dispersion and quantity of statements by individual board members as well as their impact on market interest rates were used as proxies for public signals. Finally, the dispersion of market forecasts for inflation and GDP along with the volatility of market interest rates were used to proxy for private signals. Their estimates on U.S. data confirmed that precise signals from the bank improved the predictability of central bank decisions, whereas dispersed signals worsened the predictability. Ehrmann and Fratzscher also found that central bank signals are more effective in cases of high market uncertainty.

Cecchetti (2009) scrutinized the effects of inflation targeting on the dispersion of private forecasts. Using panel data from 15 countries over 20 years, Cecchetti finds little evidence that inflation targeting leads to any reduced dispersion of the private forecasts of inflation—the impact of adopting inflation targeting is only significant for a few countries and is always small.

Fujiwara (2005) exploits the data on central bank and private forecasts in Japan, where central bank forecasts are published twice a year. The results suggest that private forecasters are influenced by the central bank forecasts. No influence is found in the opposite direction, though this might be a result of the low number of observations.

In the most recent piece of research in this area, Ehrmann et al. (2010) confront the dispersion of private forecasts with different aspects of central bank transparency, including the Eijffinger and Geraats (2006) transparency index and the publication of inflation and GDP forecasts. They conclude that transparency has a significant and sizeable effect on forecast dispersion by announcing a target, other forms of communication, or by publishing inflation and GDP forecasts.

Focusing on the Czech Republic, numerous papers have been published analysing the effects of Czech National Bank (CNB) communication (e.g. Böhm et al. 2009; Bulíř et al. 2007). However, the issue of coordination between the central bank and private forecasts has been neglected so far. Navrátil and Kotlán (2005) dealt marginally with the coordination issue, analysing the behaviour of the differentials between market interest rates and the CNB's interest rate forecasts. They found that market rates converged toward the CNB's interest rate trajectory in five cases out of eight. However, because of a limited number of observations, they questioned the robustness of their findings.

To summarise, the empirical papers point to the existence of coordination effect of publishing central bank forecast. However, the size and significance of the effect varies across countries and used methodology, and is relatively small compared to the effect of announcing inflation target.

3. Data and methodology

We start our analysis by studying the spreads among private agent forecasts before and after the central bank's forecast is published. We proceed by scrutinizing the distance of the private forecasts from the central bank forecast. Finally, we check the effects of enhanced transparency and overall macroeconomic uncertainty on the distance. In this step, we also take into account the risk assessments made by the board members, the forecasts of the Ministry of Finance and the actual economic developments and statistical releases in the period between two central bank forecasts.

The main hypotheses under our review are: (i) financial market analysts tend to coordinate their forecasts for the Czech economy via the CNB forecast, (ii) this coordination also depends on macroeconomic uncertainty, and (iii) improvements in CNB communication have deepened the coordination effect.

3.1 Data

The empirical testing of our hypotheses was made using data from the Czech Republic. The CNB introduced inflation targeting in 1998 and since then has ranked among the most transparent central banks—the Czech Republic ranks 4th among 100 countries in the central bank transparency rankings constructed by Dincer and Eichengreen (2007). The CNB forecast is released quarterly at the beginning of February, May, August and November.[2] The CNB forecasts are disclosed immediately after the monetary policy-related board meetings. Besides the forecast for headline inflation, monetary policy relevant inflation (headline inflation adjusted for the direct effects of indirect taxes) and real GDP growth, the interest rate and the exchange rate consistent with the forecast are also published. All modelling apparatus, including all equations and assumptions, is also made public.

In this paper we use a sample of the CNB's forecasts published between July 2002 and March 2010. Prior to July 2002, the forecasts were based on the assumption of a stable interest rate and, because of this, they cannot be directly compared with private forecasts, which inherently anticipate changes in interest rates. When searching for possible coordination, we focus on four key macroeconomic indicators—headline CPI inflation, real GDP growth, the short-term interest rate (3M PRIBOR) and the CZK/EUR nominal exchange rate. The forecast consists of quarterly forecasted figures, up to seven quarters ahead. In this paper we compare the inflation, interest rate and exchange rate forecasts for the one-year horizon and GDP forecasts for the current and next year.

While the CNB forecasts for inflation and GDP started to be published shortly after the introduction of inflation targeting in 1998, the interest rate forecast was not published using figures before January 2008 and the exchange rate forecast was not published before January 2009. However, verbal descriptions of interest rate and exchange rate forecasts have been provided since July 2002. Today, all CNB forecasts (including the interest rate and exchange rate forecasts, which were then released only verbally)

---

[2] Until the end of 2007, all forecasts were released at the end of January, April, July and October.

are available for the public,[3] so we use these numerical values of the forecasts and assume that the verbal descriptions were unbiased. This allows us to quantify the effect of changes in the interest rate and exchange rate communication on the coordination of private forecasts.

For private forecasts we use the data from a survey among financial market participants called Financial Market Inflation Expectations. This monthly survey is conducted among both domestic and foreign-based private economists active in the Czech financial sector. The answers for the survey are collected approximately in the middle of the month.

As with the CNB forecasts, we are interested in private forecasts for four key macroeconomic indicators—inflation, the interest rate[4] and the exchange rate at the one-year horizon, and GDP growth in the current and next year. We use monthly data, looking at the behaviour of private forecasts before and after the release of the central bank forecast. Besides employing a median forecast, we also use individual responses to calculate the standard deviation of individual forecasts in each month, i.e.

$$s_{Ffm} = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(X_i^F - \overline{X}^F\right)^2},$$

where X_i^F is the forecast of the i-th private forecaster and n is the number of private forecasters participating in the survey in a given round. Typically, about 10–15 respondents take part in the survey, with the vast majority of them being based in the Czech Republic.[5] Low number of survey participants does not allow us to adjust the sample for outliers or use the inter-quartile range of forecasts (Mankiw et al. 2003).

The CNB and median private forecasts of the interest rate, inflation and the exchange rate at the one-year horizon as well as the current and next year GDP growth forecasts are displayed in Figures 1 to 5, along with the evolution of the standard deviations of the individual forecasts. In addition, actual values of the forecasted variables are shown which allows the reader to see relative accuracy of the forecasts.

---

[3] The historical forecasts are retrospectively released in the Inflation Report, Chapter III.1.1 Fulfilment of the inflation target.

[4] Whereas the CNB interest rate forecast is in terms of 3-month market interest rates (3M PRIBOR), analysts are surveyed on interest rates in terms of 2-week repo rates and 12M PRIBOR. We use the 2W repo rate and assume that the spread between 2-week and 3-month interest rates is stable and close to zero. This assumption was fully satisfied before autumn 2008. With the outbreak of the financial crisis the spread between 2-week and 3-month interest rates widened significantly. However, it is reasonable to assume that the forecasted spread at the one-year horizon remained relatively small.

[5] Because there are usually only one or two foreign-based respondents in each round of the survey, we do not have enough observations to run a separate estimation for foreign-based analysts, although this estimation could have brought us some interesting insights.
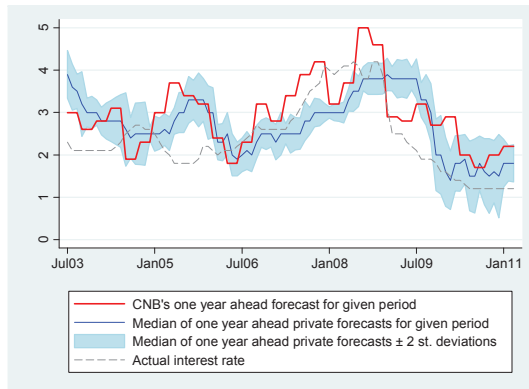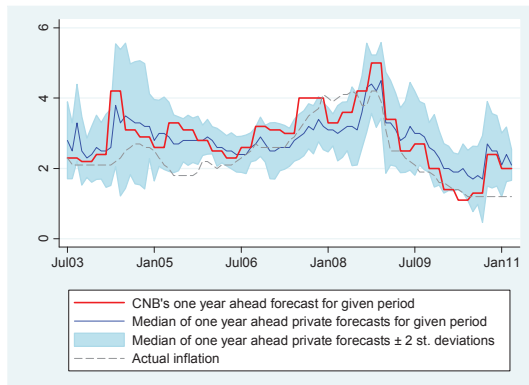
Figure 1. One year ahead interest rate forecasts

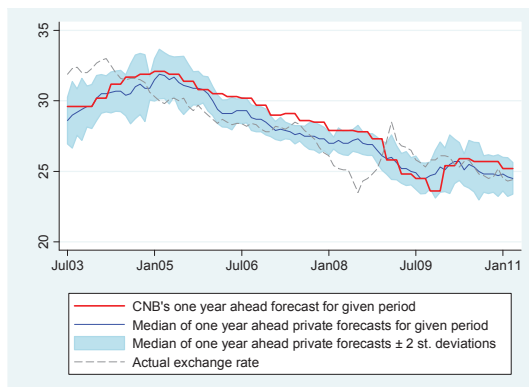**Figure 2.** One year ahead inflation forecasts

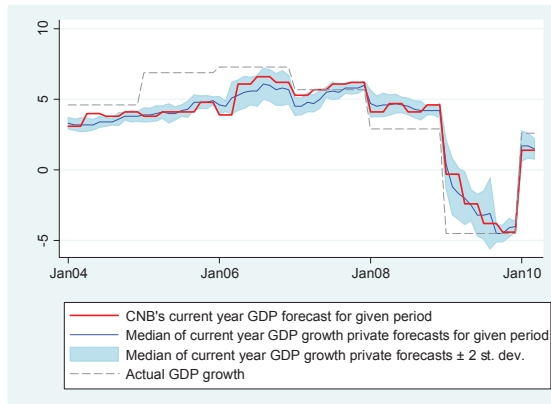**Figure 3.** One year ahead exchange rate forecasts

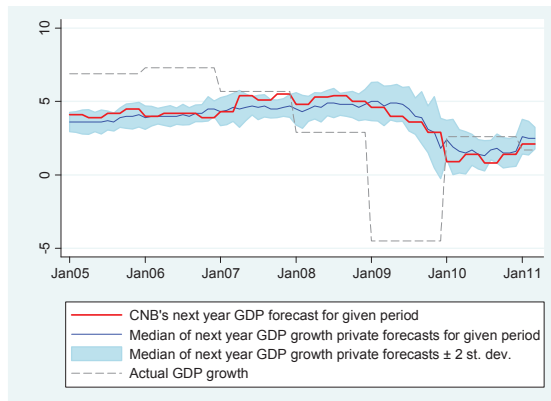**Figure 4.** Current-year GDP growth forecasts

Figure 5. Next-year GDP growth forecasts

3.2 Methodology

To test our first hypothesis, i.e., the hypothesis that financial market analysts coordinate their forecasts of the Czech economy via the CNB forecast, we analyse three sets of monthly private forecasts for each release of the quarterly CNB forecast. The first set of private forecasts comprises the last available forecasts before each release of the quarterly CNB forecast. The second set are those private forecasts which are surveyed immediately after the release of the CNB forecast. The third set of private forecasts are the forecasts surveyed approximately one month after the release of the CNB forecast.

We calculate two indicators for each set: the standard deviation of the private forecasts and the median absolute distance from the CNB forecast and analyse evolution of each indicator over the period of one month before and two months after the CNB forecast release. To take into account the decreasing uncertainty surrounding current

and next year GDP forecasts, we regress the standard deviation (distance) on three time dummies (last before, first after, second after) as well as a decreasing trend variable controlling for the calendar effect. Besides providing a graphical representation of the forecast standard deviation and distance evolution, we test the null hypothesis of no change in the standard deviation (distance) of the financial market forecasts after the release of the CNB forecast against the alternative hypothesis of an increase or decrease in the standard deviation (distance). We use a pairwise t-test, i.e., the test statistics for each variable is

$$t = \frac{\overline{D}_{S_{Ffm}}}{\frac{s_{D_{S_{Ffm}}}}{\sqrt{n}}},$$

where $\overline{D}_{S_{Ffm}}$ is the average of the differences between the standard deviation (distance) before and after the release of the CNB forecast.

We proceed by testing the second hypothesis, which states that the coordination effect depends on macroeconomic uncertainty. It is based on the expectation that private forecasters stick to the CNB forecast more tightly at times of higher uncertainty. To proxy the uncertainty, we calculate the three-month average of the standard deviations of the individual private forecasts (i.e., the cross-sectional standard deviations) for each forecasted variable and for each quarter. Based on the comparison of the standard deviations in each quarter with the average standard deviation over the whole sample, the low and high uncertainty quarters are defined for each variable.

As an alternative to the uncertainty proxy defined individually for each variable, we also define overall uncertainty. This is the sum of the standard deviations of the individual private forecasts of all five variables considered, where the time series of standard deviations for all variables are standardized before adding them up:

$$s_{Ffm,t,j}^{stnd} = \frac{s_{Ffm,t,j}}{\sqrt{\frac{1}{l_j-1} \sum_{i=1}^{l_j} \left(s_{Ffm,i,j} - \overline{s}_{Ffm,i,j}\right)^2}} - \overline{s}_{Ffm,j}$$

$$overall\ uncertainty_t = \frac{1}{5} \sum_{k=1}^{5} s_{Ffm,t,k}^{stnd}$$

where $s_{Ffm,t,j}$ is the standard deviation of the individual private forecasts for variable j at time t and l_j is the length of the time series for variable j. The same applies to the distance from the CNB forecast.

As with the previous definition of uncertainty, we define quarters in which the uncertainty is below or at the average as being low uncertainty quarters. Similarly, quarters with uncertainty above the average are high uncertainty quarters.

Finally, we test the hypothesis that improvements in CNB communication have deepened the coordination effect. The way the CNB forecasts were communicated was different for the different variables and changed over time. For example, interest rate and exchange rate forecasts were described verbally before 2008, whereas inflation and GDP forecasts were published using figures. As there are different communication methods for different variables and periods we can evaluate the impact of enhanced

communication (e.g., the start of interest rate forecast publication using fan charts in January 2008) on the coordination effect. The effect of improved communication is estimated by adding dummy variables into the regressions. The changes in CNB communication are expected to deepen the coordination effect, but we cannot *a priori* rule out the opposite result. As Mishkin (2004) pointed out, increased transparency, for example, announcing a projection of the policy rate path, might complicate communication with the public and could hurt the central bank's credibility.

4. Results

We start answering the question of whether the variability of individual private forecasts is smaller when the CNB forecast is released by examining the standard deviations of the individual forecasts before and after the CNB forecast is released. The first column of each graph in Figure 6 depicts the standard deviation of the individual forecasts in the last survey before the release of the CNB forecast. The second column depicts the standard deviation of the individual forecasts immediately after the CNB forecast is released. Finally, the third column shows the standard deviation approximately one month after the CNB forecast is released.
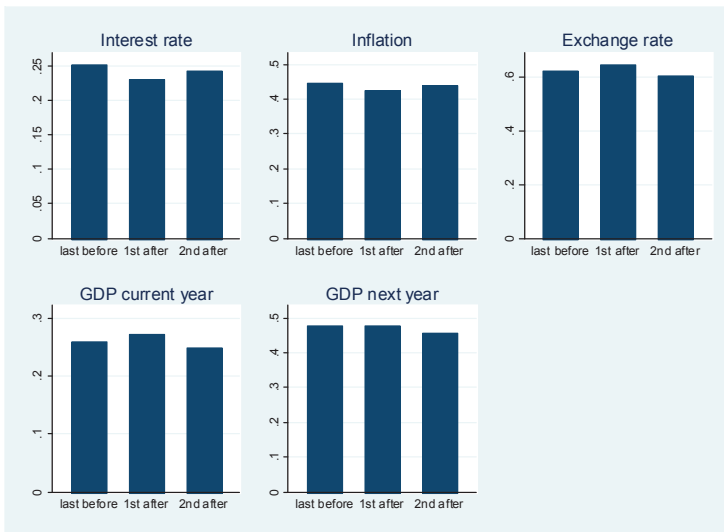

Figure 6. The evolution of the average standard deviation of private forecasts before and after the release of the CNB forecast

In the cases of interest rates and inflation, the standard deviation of private forecasts is smallest immediately after the release of the CNB forecast and then increases. In the case of exchange rates, the standard deviation is highest after the release and then decreases. Similarly, the standard deviation of the GDP forecasts for the current and next year increases after the CNB forecast and decreases afterwards.

These results are consistent with intuition. The CNB has the power to steer the interest rate as its main instrument. Hence, the interest rate forecast is mostly credible and its publication reduces the uncertainty of private forecasts. As an inflation-targeting central bank, the CNB inflation forecast is also considered credible. However, the CNB forecasts for the remaining indicators—the exchange rate and GDP—are perceived as being less credible and their publication does not reduce the uncertainty among private forecasters. The highest exchange rate uncertainty at the time of publishing the CNB forecast might be explained by higher exchange rate volatility surrounding the CNB decision-taking, which coincides with the publication of the forecast. The standard deviation of the current and next year GDP forecasts is likely to be heavily influenced by statistical releases. A flash estimate of previous quarter GDP is released in February, May, August and November and is fully reflected in the March, June, September and December private forecast surveys. As such, it influences the standard deviation in the second month after the CNB forecast publication. Similarly, the release of national account statistics might have an influence on the standard deviation of private forecasts in the month before the CNB forecast is published.

In addition to the graphical analysis, we also run t-tests. The test results summarized in Table A1 in the Appendix show that we can reject the null hypothesis of no change or increase against the alternative hypothesis of a decrease in the standard deviation after the release of the forecast at a 5% level of significance only in the case of interest rates.

The second part of our analysis is focused on the median absolute distance of private forecasts from the CNB forecast.[6] Theoretically, if coordination exists, this distance should narrow after the CNB forecast is published and then broaden again as new information arrives.

There are at least two drawbacks to this analysis. First, some important pieces of new information (e.g., headline inflation, and in some periods also the GDP flash estimates) become available immediately after the CNB forecast is released and before the private forecasts are surveyed. This might loosen the link between the CNB forecast and the private forecasts. Second, the fact that the CNB forecasts quarterly data, whereas the private forecasters reveal expected monthly developments, might also negatively influence the link. For example, if we are in the first quarter and inflation is expected to rise steadily over the first quarter of the next year, then the private forecasts in January are likely to be below the CNB forecast for the first quarter, the private forecasts for February should be closer to the CNB forecast and, finally, the March private forecasts are likely to be above the CNB forecast. These complications might bias our estimates.

Figure 7 shows that the distance between the private forecasts and the CNB forecast decreases after the release of the CNB forecast in the case of interest rates, inflation and GDP growth in the current year. On the contrary, the distance increases in the case of exchange rates. The distance for GDP growth in the next year remains broadly stable.

The loose link between the private and CNB forecasts of exchange rates might

---

[6] Running the analysis with the mean absolute distance yields almost the same results.
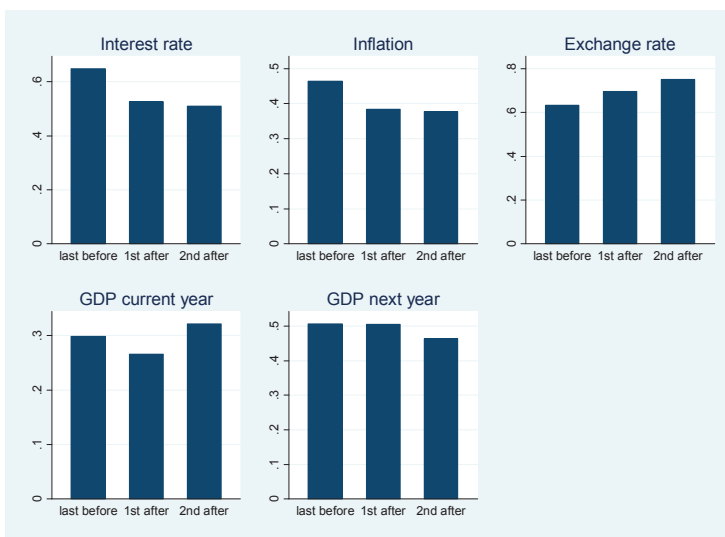
Figure 7. The sensitivity of the median absolute distance of private forecasts from the CNB forecast on the release of the latter

be explained by the idea presented in the two paragraphs above—the exchange rate forecast (and the actual exchange rate) is affected by new information, and this effect is stronger than for the other forecasted variables. The private forecasts are continuously updated to include new information and actual exchange rate levels, sharply contrasting with the CNB forecasts, which draw on exchange rates observed at the beginning of the forecasting process. This idea is supported by internal research by the CNB (Syrovátka 2009) showing that private exchange rate forecasts are more precise than the CNB's forecast. Also, private exchange rate forecasts might reveal self-fulfilling properties as, for example, forecasting stronger exchange rates might reinforce the buying of Czech crown-denominated assets. Finally, we should bear in mind that the CNB started to publish exchange rate forecasts only in 2009. Before 2009, the CNB used to reveal only limited information about its exchange rate forecasts, typically in the form of vague sentences.[7] Any coordination based on such information is dramatically less likely than coordination based on available numerical forecasts.

The distance between the next year's private GDP growth median forecast and the CNB forecast remains almost unchanged in the first month after the release of the CNB forecast. However, in the second survey after the release, the distance narrows significantly. It is possible that in the case of GDP forecasts for the next year it takes some time to convince the private forecasters about the message of the forecast.

The results of hypothesis testing in Table A2 in the Appendix complement the graphical presentation. The decrease of the absolute distance between the median of

---

[7] For example, the following sentence described the exchange rate forecast in the Inflation Report published in November 2008: "After initial fluctuations, the nominal exchange rate will again steadily appreciate."

the private forecasts and the CNB forecast immediately after the release of the latter is statistically significant at the usual significance levels in the cases of interest rates and inflation.

We continue our analysis by scrutinizing if and how our results change during times of higher uncertainty. Quarters are divided into two groups depending on the value of average standard deviation of the private forecasts over the quarter. The quarters with standard deviation higher than the average standard deviation over the whole sample are labelled "high uncertainty" quarters. The other quarters are labelled "low uncertainty" quarters. Figure 8 provides the first view of the relationship between uncertainty and the distance of the CNB forecast from the median of the private forecasts.[8] The distance of the CNB forecasts from the private forecast median is substantially smaller during high uncertainty periods than at times of low uncertainty in the cases of interest rates and exchange rates. On the contrary, in the case of GDP forecasts for the current year, the distance is greater in uncertain times. In addition, Figure 8 shows that under high uncertainty, the distance decreases after the release of the CNB forecast in the cases of all five forecasted variables except for the exchange rate. The results of one-sided paired t-tests in Tables A3 and A4 in the Appendix show that the decrease of the distance after the release of the CNB forecast is statistically significant at the 1% level in the case of interest rates under low uncertainty and at the 10% level in the cases of interest rates and inflation at times of high uncertainty.
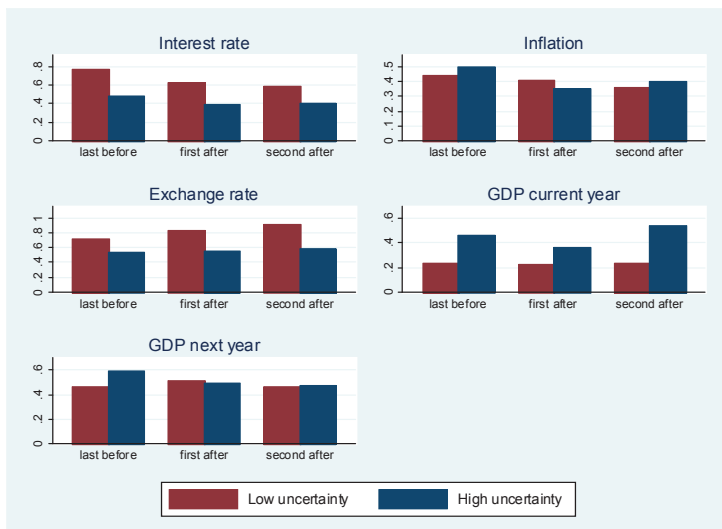
Figure 8. The sensitivity of the median absolute distance of private forecasts from the CNB forecast on the release of the latter, depending on the degree of uncertainty

---

[8] As high and low uncertainty periods are built using the standard deviations of private forecasts, we only examine the relationship between uncertainty and the distance of the CNB forecast from the median of the private forecasts, i.e. we do not look at the relationship between uncertainty and the standard deviation of private forecasts.

In an alternative setup, the overall uncertainty is used instead of the uncertainties based on the standard deviations of the individual series. Qualitatively, the results differ mainly in the case of the current year GDP forecasts (available upon request). This might reflect the fact that the set of uncertainties surrounding the current year GDP is often different from the set of uncertainties influencing forecasts at the one year horizon.

In the final step, we examine whether the sensitivity of private forecasts to the CNB forecast varies with the way the CNB forecast has been communicated. In our sample period, four improvements in the CNB forecast communication can be identified. In January 2005 the CNB started to publish a detailed decomposition of inflation and GDP forecasts. Since April 2007 spreadsheets with underlying datasets for all figures and tables in the Inflation Report, including the interval forecast for inflation and GDP, have been made available on the CNB website. These spreadsheets have newly provided users with very precise information on the CNB forecast. Most importantly, forecasts for quarterly GDP became available, whereas only forecasts for annual GDP had been published before. In January 2008 the CNB started releasing forecasts for interest rates. The CNB also improved the way the forecasts of key variables are communicated and introduced fan charts with confidence intervals based on previous forecasting performance. Finally, since January 2009 the CNB has also been reporting its exchange rate forecast using figures.

In order to capture the effects of the CNB forecast communication changes on the distance between private and CNB forecasts, we introduce four dummy variables for the time period in which improved communication was put in place. The dummies are effective only in the first months after the CNB forecast is released, since all communication takes place immediately after the release. For example, the first communication dummy is named "Decomposition" and has value 0 before January 2005 and 1 in all "first after" periods afterwards.

In this step we introduce several additional variables which might also be helpful in explaining the sensitivity of private forecasts to the CNB forecast. The first of these additional variables captures actual economic developments and statistical releases in the period between two central bank forecasts. Where possible, we construct this variable as the absolute deviation of the actual data from the CNB forecast. Where this approach is not feasible, we use the absolute deviation of the actual data from the previous statistical release. The variable is labelled "Surprise" in Table 1.

The second additional variable is a dummy which describes the risk assessment of the forecast, as discussed at the board meeting and published immediately at the press conference.[9] This dummy takes a value of 0 if the risks are perceived as balanced and 1 if risks are either inflationary or disinflationary. The logic behind using this variable is that once the board assesses the forecast as biased in either direction, the market might also discount the forecast and the coordination effect is then expected to be smaller.

---

[9] Before 2008, there were 12 meetings per year, i.e., the risks of the forecast were reassessed each month. Starting from 2008, the number of meetings was reduced to 8 per year.

Table 1. The effect of changes in communication, actual economic developments, risk assessment and the forecast of the Ministry of Finance on the median absolute distance of private forecasts from the CNB forecast

	Interest rate	Inflation	Exchange rate	GDP current year	GDP next year
			Dependent variable		
Last before	0.58 ***	0.51 ***	0.71 ***	0.31 ***	0.49 ***
	[0.08]	[0.07]	[0.09]	[0.09]	[0.11]
First after	0.29 ***	0.22 ***	0.46 ***	0.21 *	0.48 ***
	[0.09]	[0.05]	[0.16]	[0.11]	[0.11]
Second after	0.44 ***	0.36 ***	0.76 ***	0.28 ***	0.41 ***
	[0.09]	[0.07]	[0.11]	[0.08]	[0.10]
Decomposition (Jan 05)	0.19	0.11	0.64 ***	0.08	−0.06
	[0.18]	[0.11]	[0.14]	[0.12]	[0.12]
Spreadsheets (Apr 07)	0.20	0.23 *	−0.16 ***	0.21 *	0.17
	[0.26]	[0.14]	[0.06]	[0.12]	[0.13]
IR forecast (Jan 08)	−0.06	−0.28 **	−0.45 **	−0.32 ***	−0.21
	[0.32]	[0.11]	[0.20]	[0.12]	[0.20]
ER forecast (Jan 09)	−0.26	0.22	0.15	0.10	0.14
	[0.30]	[0.15]	[0.22]	[0.15]	[0.24]
Surprise	0.62 *	−0.15	−0.23	0.09 **	0.02
	[0.32]	[0.09]	[0.15]	[0.04]	[0.08]
Risk assessment	0.03	0.12 *	0.15	−0.02	0.05
	[0.10]	[0.07]	[0.11]	[0.08]	[0.09]
Ministry of Finance		0.12		0.49 ***	0.11
		[0.09]		[0.12]	[0.17]
Approaching end-of-the-year				0.01	0.00
				[0.01]	[0.01]
Number of observations	93	89	93	75	75
R^2	0.74	0.72	0.79	0.76	0.69
F-test p-value H_0: Last before = First after	0.01	0	0.13	0.34	0.93

Notes: Dependent variables are the median absolute distances of private forecasts from the CNB forecast for the respective variables. Last before, First after and Second after are time dummies corresponding to the respective round of private forecasts. Surprise is the difference between the two most recent monthly values in the case of the interest rate and the exchange rate, the difference between the recent monthly value and the CNB forecast in the case of inflation and the difference between the two most recent GDP growth quarterly values in the case of GDP (set to zero in the months without a new release). Decomposition, Spreadsheets, IR forecast and ER forecast are dummies equal to one in the "first after" period since the respective changes in communication were introduced. Risk assessment is a dummy equal to one if the board's assessment of the risks is non-neutral. Ministry of Finance is a dummy equal to one if the forecasts of the CNB and the Ministry of Finance differ by more than 1 perc. point for the respective variables. Approaching end-of-the-year is a trend variable controlling for decreasing uncertainty about the yearly figure in the case of GDP forecasts. Statistical significance: *** significant at 1%, ** significant at 5%, * significant at 10%; robust standard errors in brackets.

Finally, we also construct a dummy exploring the potential coordination role of another influential forecaster in the Czech Republic: the Ministry of Finance. Because the Ministry of Finance forecast assumes exchange rates and interest rates as being constant, we draw only on the inflation and GDP forecast. The dummy is set to 1 if the

ministry's forecast for a given variable differs by more than one percentage point from the CNB forecast, and zero in other cases.

We insert all the explanatory variables into the regression estimating the sensitivity of the median absolute distance of private forecasts from the CNB forecast on the release of the latter. The regression results are reported in Table 1.

The estimated coefficients of the dummies connected with our three sets of private forecasts (last before, first after, second after) show, compared to Figure 7, a more pronounced decline after the release of the CNB forecast in the cases of the interest rate, inflation, the exchange rate and current year GDP. Thus, adding more explanatory variables makes the coordination effect more pronounced. In terms of statistical significance, last row of the table shows the p-values of the F-test testing the equality of coefficients "last before" and "first after". These are in line with the results of simple t-tests in Table A2: the decrease of the distance after the release of the CNB forecast is statistically significant only for interest rate and inflation.

The first additional variable, entitled Surprise, captures the effect of actual economic developments. These are influential and come with the correct sign for the interest rate and current year GDP—the bigger the surprise, the bigger the distance of private forecasts from the CNB forecast. The next four rows of Table 1 contain dummies capturing the communication effects (Decomposition, Spreadsheets, IR forecast and ER forecast). Higher coordination effects of central bank forecasts should be revealed by negative estimates of regression coefficients. The communication shifts have significant and intuitive effects only in the cases of inflation (publishing interest rate forecast), the exchange rate (publishing spreadsheets and interest rate forecasts) and current year GDP (publishing interest rate forecasts). In the case of other variables and communication dummies, no effects or adverse effects are identified. The risk assessment is slightly significant only for inflation. This seems intuitive because the risks of the forecast are assessed mainly for inflation and verbally described as inflationary or disinflationary. At times when the current year GDP forecast of the Ministry of Finance differs from the CNB forecast by more than one percentage point, private forecasts tend to move away from the CNB forecast, with no similar effect being observable in the cases of next year GDP and inflation.

In addition, we investigated whether the past accuracy of central bank forecasts strengthens the coordination effect. A proxy for the relative past accuracy of central bank and median private forecasts[10] was included in the previous regression. The coefficient of the proxy was significant for inflation and GDP in the current year. Its sign and size suggest that private forecasters evaluate the past accuracy of central bank

---

[10] In the first step, the absolute accuracy was calculated for both the central bank and private forecasters as the absolute difference between the forecasted and actual values. The moving average of the ratio of the two accuracy measures including the past 12 months was then constructed and used as a proxy for relative accuracy:

$$past\ accuracy_t = \frac{1}{12} \sum_{i=1}^{12} \frac{\left| X_{t-12-i,t-i}^{Ffm} - X_{t-i}^{A} \right|}{\left| X_{t-12-i,t-i}^{Fcb} - X_{t-i}^{A} \right|},$$

where $X_{t-12-i,t-i}^{Ffm}$ and $X_{t-12-i,t-i}^{Fcb}$ are one-year ahead forecasts made by the financial markets (median) and the central bank $12 + i$ months ago, and X_{t-i}^{A} is the actual outcome available at the time i months ago.

forecasts and tend to use these forecasts for coordination more intensively after periods of higher relative success of central bank forecasts.[11]

5. Conclusions

We investigated the possibility that private forecasters coordinate their forecasts through the forecast of the central bank, in this case the CNB. When looking at the evolution of the standard deviation, only the standard deviation of the individual forecasts of interest rates decreases significantly after the release of the CNB forecast. When looking at the distance of the median of private forecasts from the CNB forecast, the forecasts of the interest rate and inflation show a significant decrease in the distance after the release of the CNB forecast. Finally, in search of the effects of uncertainty, we find that the distance of the median of private forecasts from the CNB forecast tends to be smaller during times of high uncertainty compared to times of low uncertainty in the cases of the interest rate and the exchange rate.

While the forecasts of the interest rate and inflation provide relatively strong support for the theory of coordination via central bank forecasts, the GDP and exchange rate forecasts provide almost no support. However, these results are consistent with intuition. The CNB has the power to steer the interest rate as its main instrument. Hence, the interest rate forecast is mostly credible and its publication reduces the uncertainty of private forecasts. As an inflation-targeting central bank, the CNB inflation forecast is also considered credible. However, the CNB forecasts for the remaining indicators—the exchange rate and GDP—are perceived as being less credible and their publication does not reduce the uncertainty among private forecasters.

We analysed the effects of changes in forecast communication in more detail and found that communication has supported the coordination of private forecasters in the case of inflation (publishing interest rate forecasts), the exchange rate (publishing spreadsheets and interest rate forecasts) and current year GDP (publishing interest rate forecasts). Furthermore, actual economic developments have an impact on the interest rate and current year GDP forecasts. The GDP forecasts are also influenced by the Ministry of Finance forecast. Finally, the forecast for inflation is sensitive to the risk assessment made by the CNB's board members.

---

[11] Due to a substantial decrease in the number of usable observations caused by the calculation of past accuracy, we consider the results presented in Table 1 to be preferable. The results with past accuracy among the explanatory variables are not reported and can be obtained upon request.

References

Bauer, A., Eisenbeis, R., Waggoner, D. and Zha, T. (2006). Transparency, Expectations, and Forecasts. *Federal Reserve Bank of Atlanta Economic Review*, 91(1), 1–25.

Bikhchandani, S. and Sharma, S. (2000). Herd Behavior in Financial Markets: A Review. Washington, International Monetary Fund, IMF Working Paper No. 00/48.

Böhm, J., Král, P. and Saxa, B. (2009). Perception is Always Right: The CNB's Monetary Policy in the Media. Prague, Czech National Bank, CNB Working Paper No. 10.

Bulíř, A., Šmídková, K., Kotlán, V. and Navrátil, D. (2007). Inflation Targeting and Communication: Should the Public Read Inflation Reports or Tea Leaves. Prague, Czech National Bank, CNB Working Paper No. 14.

Cecchetti, S. G. (2009). Inflation Targeting and Private Sector Forecasts. Cambridge MA, National Bureau of Economic Research, NBER Working Paper No. 15424.

Cukierman, A. (2001). Accountability, Credibility, Transparency and Stabilization Policy in the Eurosystem. In Wyplosz, C. (ed.), *The Impact of EMU on Europe and the Developing Countries*. Oxford, Oxford University Press, 40–75.

Dincer, N. and Eichengreen, B. (2007). Central Bank Transparency: Where, Why, and with What Effects? Cambridge MA, National Bureau of Economic Research, NBER Working Paper No. W13003.

Ehrmann, M. and Fratzscher, M. (2007). Social Value of Public Information: Testing the Limits to Transparency. Frankfurt am Main, European Central Bank, Working Paper No. 821.

Ehrmann, M., Fratzscher, M. and Eijffinger, S. (2010). The Role of Central Bank Transparency for Guiding Private Sector Forecasts. Frankfurt am Main, European Central Bank, Working Paper No. 1146.

Eijffinger, S. and Geraats, P. (2006). How Transparent Are Central Banks? *European Journal of Political Economy*, 22, 1–21.

Eijffinger, S. and Tesfaselassie, M. F. (2007). Central Bank Forecasts and Disclosure Policy: Why It Pays to be Optimistic. *European Journal of Political Economy*, 23, 30–50.

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

Fukač, M. (2006). New Keynesian Model Dynamics under Heterogeneous Expectations and Adaptive Learning. Prague, Czech National Bank, CNB Working Paper No. 5.

Geraats, P. M. (2001). Why Adopt Transparency? The Publication of Central Bank Forecasts. Frankfurt am Main, European Central Bank, Working Paper No. 41.

Jensen, H. (2002). Optimal Degrees of Transparency in Monetary Policy-Making. *Scandinavian Journal of Economics*, 104, 399–422.

Kydland, F. E. and Prescott, E. C. (1977). Rules Rather Than Discretion: The Inconsistency of Optimal Plans. *Journal of Political Economy,* 85(3), 473–491.

Mankiw, N. G., Reis, R. and Wolfers, J. (2003). Disagreement About Inflation Expectations. In *NBER Macroeconomics Annual* 2003, Volume 18. Cambridge MA, MIT Press, 209–270.

Mishkin, F. S. (2004). Can Central Bank Transparency Go Too Far? Cambridge MA, National Bureau of Economic Research, NBER Working Paper No. 10829.

Morris, S. and Shin, H. S. (2002). Social Value of Public Information. *American Economic Review*, 92, 1521–1534.

Navrátil, D. and Kotlán, V. (2005). The CNB's Policy Decisions: Are They Priced in by the Markets? Prague, Czech National Bank, CNB Research and Policy Notes No. 1/2005.

Reserve Bank of New Zealand (1985). A Quarterly Review of the New Zealand Economy. *Reserve Bank Bulletin*, 48(5), 223–227.

Svensson, L. E. O. (2006). Social Value of Public Information: Morris and Shin (2002) Is Actually Pro Transparency, Not Con. *American Economic Review*, 96, 448–451.

Syrovátka, J. (2009). Analysts' Forecasts in the Survey of Financial Market Inflation Expectations. Appendix in the *6th Situation Report on Economic and Monetary Developments*, internal document of the Czech National Bank, to be published in January 2016.

Appendix

Table A1. Hypothesis testing: standard deviation of private forecasts

	No. of obs.	Last before CNB forecast	First after CNB forecast	One-sided pairwise t-test p-value†	Second after CNB forecast
Interest rate	31	0.25	0.23	0.04 **	0.24
Inflation	31	0.45	0.42	0.14	0.44
Exchange rate	31	0.62	0.65	0.78	0.60
GDP current year	25	0.26	0.27	0.71	0.25
GDP next year	25	0.48	0.48	0.49	0.46

Notes: The null hypothesis of no change or increase against the alternative hypothesis of a decrease of the standard deviation of private forecasts after the release of the CNB forecast. ** indicates statistical significance at 5%.
† H_0: last before $\le$ first after.

Table A2. Hypothesis testing: distance from CNB forecast

	No. of obs.	Last before CNB forecast	First after CNB forecast	One-sided pairwise t-test p-value†	Second after CNB forecast
Interest rate	31	0.65	0.53	0.00 ***	0.51
Inflation	31	0.46	0.38	0.05 *	0.38
Exchange rate	31	0.63	0.70	0.91	0.75
GDP current year	25	0.30	0.27	0.17	0.32
GDP next year	25	0.51	0.50	0.49	0.46

Notes: The null hypothesis of no change or increase against the alternative hypothesis of a decrease of the distance between the private forecasts and the CNB forecast after the release of the latter. *** and * indicate statistical significance at 1% and 10% respectively.
† H_0: last before $\le$ first after.

Table A3. Hypothesis testing: Distance from CNB forecast under low uncertainty

	No. of obs.	Last before CNB forecast	First after CNB forecast	One-sided pairwise t-test p-value†	Second after CNB forecast
Interest rate	18	0.77	0.62	0.00 ***	0.58
Inflation	18	0.44	0.41	0.17	0.36
Exchange rate	16	0.72	0.83	0.97	0.91
GDP current year	18	0.24	0.23	0.39	0.24
GDP next year	16	0.46	0.52	0.93	0.46

Notes: The null hypothesis of no change or increase against the alternative hypothesis of a decrease of the median distance of private forecasts from the CNB forecast after the release of the CNB forecast. Low uncertainty environment. *** indicates statistical significance at 1%.
† H_0: last before $\le$ first after.

Table A4. Hypothesis testing: Distance from CNB forecast under high uncertainty

	No. of obs.	Last before CNB forecast	First after CNB forecast	One-sided pairwise t-test p-value[†]	Second after CNB forecast
Interest rate	13	0.48	0.39	0.09 *	0.41
Inflation	13	0.49	0.35	0.09 *	0.40
Exchange rate	15	0.54	0.55	0.57	0.59
GDP current year	7	0.46	0.36	0.17	0.54
GDP next year	9	0.59	0.49	0.13	0.47

Notes: The null hypothesis of no change or increase against the alternative hypothesis of a decrease of the median distance of private forecasts from the CNB forecast after the release of the CNB forecast. High uncertainty environment. * indicates statistical significance at 10%.
[†] H_0: last before $\leq$ first after.