CHAPTER 7

EVALUATION OF THE QUALITY AND SUCCESS RATE OF FORECASTS – A HISTORIC OVERVIEW

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1. INTRODUCTION

This paper sets out to contribute to the debate about the fulfilment of past inflation targets by evaluating the quality and success rate of forecasts as the basis for monetary policy decisions. Furthermore, it strives to identify and sum up the factors underlying deviations from reality in past forecasts. The terms "success rate" and "quality" refer to the degree of fulfilment of the individual forecasts for key macroeconomic variables[1] and thus also of their stories.

The paper deals solely with forecasts produced by the CNB and does not compare them with those produced by other institutions. Therefore, we talk here only about higher or lower success rates of particular CNB forecasts based on comparisons between them. It is up to the reader to decide whether the forecasts can be deemed truly successful or unsuccessful from the external point of view.

The CNB's Monetary and Statistics Department regularly identifies the factors underlying the non-fulfilment of its forecasts and uses such analyses to adjust the forecasting mechanism and its tools. Evaluations of 18-month-old forecasts are contained in an internal document entitled *Evaluation of Inflation Target Fulfilment*. Conclusions from that document are regularly published in the *Inflation Report* in the section "Fulfilment of the inflation target".

The evaluations of the quality and success rate of forecasts submitted here are based on the individual historical *Evaluations of Inflation Target Fulfilment* and involve an overall assessment of the full set of forecasts from the beginning of 2004 until mid-2006[2].

The paper has the following structure. Following a summary of the most important results, the fulfilment of historical forecasts is evaluated. That is done first by simply comparing the forecasts with the actual developments. Next, adjusted forecasts based on knowledge of all factors are discussed and an evaluation of the fulfilment of the historical forecasts is presented in chronological order, year by year. The main part of the text is supplemented with two appendices. Key terms and methodology relating to the creation of adjusted forecasts are described in Appendix 1. Appendix 2 contains a description of the deviations of the original and adjusted forecasts from reality.

2. SUMMARY OF RESULTS

In terms of deviations from reality, the forecasts produced in the period under review deviate on average towards higher inflation, lower real growth and a less appreciated nominal exchange rate. Consistent with that, the implied interest rate path in the forecasts is also, on average, higher than the actual path. The deviations of key macroeconomic variables increase as the forecast horizon lengthens. However, the deviations gradually decrease over time, being largest for the forecasts produced in 2004. By contrast, they are lower in the case of the latest reviewed forecasts dating from 2006.

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[1] The paper deals solely with CPI inflation, the growth rate of GDP (or the output gap as the cyclical component thereof), the nominal exchange rate against the euro and nominal interest rates.

[2] Forecasts performed prior to 2004 are not included in the evaluation. At that time, the forecasts resulted from a complex process of integration of medium-term and short-term forecasting methods complemented with expert adjustments. Deducting from such forecasts and identifying errors is not easy and goes beyond the scope of this paper.

Based on an evaluation of the forecasts from 2004 until mid-2006, we have identified three basic sets of factors which have most frequently contributed to the overvaluation of the historical forecasts.

The first set comprises the influence of the settings of equilibrium variables. This set of factors is the one that has contributed most to the deviations of the forecasts from reality in the past. From the *ex-post* point of view, incorrect estimations of non-inflationary output growth and of the rate of equilibrium appreciation of the exchange rate (undervaluation in both cases) and a high past level of equilibrium interest rates caused the deviations in the forecasts. Setting the long-term trends in the forecasts is, and probably will remain, of key importance to their fulfilment. These long-term trends are determined by structural factors and are therefore hard to predict.

The second set consists of the non-fulfilment of some exogenous assumptions and the influence of unexpected shocks. First and foremost is an assumption overestimating the first-round impact of certain tax changes on inflation. Lower actual inflation was also fostered by bumper harvests of some agricultural commodities in 2004 and 2005 and by strong competition among retail chains.

The last set of factors is represented by the miscalibration of some behavioural relationships within the model system, which is the core prediction tool. Based on analyses performed during the period under review, modifications of the model equations resulted mainly in a reduction of the pass-through of energy prices and regulated prices to inflation expectations, which, in turn, led to a reduction in the inflation forecast errors.

3. EVALUATION OF THE FULFILMENT OF HISTORICAL FORECASTS

This chapter deals with the evaluation of the success rate of the forecasts in terms of forecast fulfilment by assessing the predictions for key variables such as inflation, interest rates, exchange rates and real economic activity as described by the output gap. We concentrate our evaluation on the medium-term horizon of 4–6 quarters[3].

The evaluation of the success rate of historical forecasts can be performed by assessing the deviation of the forecasted variables from reality. This evaluation is significantly simplified and does not offer complete information from the forecasters' point of view. A simple comparison of a forecast with the actual outcome of a given variable does not clearly identify the factors underlying non-fulfilment of the forecast. However, such information is important for the development, revision and modification of prediction tools. As part of the forecasting process, procedures have been developed within the CNB to help analyse past forecasts and identify the factors underlying their non-fulfilment. For more details, see *Evaluation of Inflation Target Fulfilment* in Appendix 1.

The factors underlying forecast non-fulfilment are either exogenous or endogenous to the forecasting process. Purely exogenous factors enter the forecasts in the form of assumptions, which are adopted in a relatively mechanical manner. They include in particular external variables such as foreign inflation, interest rates and real economic activity, but also domestic factors, such as assumptions about the development of regulated prices and indirect taxes. The impact of those exogenous factors on forecast non-fulfilment can be described using adjusted forecasts that take into account the actually observed evolution of those factors (see Appendix 1 and the description of the simulation techniques). These forecasts are a standard part of the internal document *Evaluation*

of Inflation Target Fulfilment and have been assembled for the entire period under review (see Appendix 2).

The other group comprises forecast assumptions that are endogenous to the forecasting process. They consist primarily of the settings of the initial conditions of the forecasts and the trends in equilibrium variables over the forecast horizon. As in the case of the exogenous factors, their impact can be evaluated using adjusted forecasts, which this time contain our current view regarding their evolution.

Such an evaluation of the factors underlying the non-fulfilment of forecasts may seem very simple at first glance. Past forecasts are complemented with the actual outcomes of the exogenous variables and the current view about the historical development of cycles and trends. We thus obtain an evaluation of their effect on the non-fulfilment of forecasts. In reality, however, it is impossible to simply compare the adjusted forecasts – based on knowledge of all (exogenous and endogenous) factors – with the actual outturns. This is mainly because of the unconditional nature of the forecasts[4] and the assumption of perfect knowledge of all exogenous variables at the forecast horizon.

The unconditional nature of the forecasts means that monetary policy will always respond to steer inflation towards the target amid the given inflation pressures. If we assume that the adjusted forecast correctly describes, *ex post*, the inflation pressures and that monetary policy responds to keep inflation on target, then the interest rate path, like the forecasts for inflation and other variables, may differ from reality. The reason may be a different *ex-post* rate response compared to the historical *ex-ante* path.

This unconditionality is joined by another major assumption used in the adjusted forecasts – that all changes in factors are fully expected. Such an assumption is unrealistic in reality. If we had known, for example, the present oil price inflation rate or international interest rates last year, the response of the economy, and thus of monetary policy, would have been different.

Therefore, the adjusted forecasts help us evaluate the contributions of individual factors, but they cannot be simply compared with the actual outturns. They allow us to identify the factors underlying the non-fulfilment of forecasts, but they need to be complemented with a detailed knowledge of the story of the forecast.

The historical forecasts, along with a knowledge of their structure and their evaluation, and the adjusted forecasts reveal that a significant proportion of the deviations of the forecasts from reality was due to *ex-post* erroneous assumptions concerning the determination of the trends in the equilibrium real exchange rate, equilibrium real interest rates and equilibrium output as compared with the contemporary view. From the point of view of the forecasting process, therefore, it was due to endogenous factors.

The non-fulfilment of the forecasts was also partly due to exogenous factors, or to assumptions about exogenous variables. Taking into account the actual development of all the exogenous factors entering forecasts, the degree of overvaluation of the inflation forecast at the horizon of 4 to 6 quarters decreases significantly. Knowledge of the actual development of those variables thus significantly assists in enhancing forecast quality as regards the overvaluation of inflation. Also,

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[3] The reason for this is the assumption applied when creating the forecasts that there is a lag in the transmission of monetary policy decisions to inflation.

[4] The forecast is unconditional in the sense that it includes the reaction of interest rates. It is therefore conditional not on an exogenous assumption about their development, but on the path that is consistent with future inflation at the target horizon.

knowledge of the actual changes to indirect taxes and the actual development of regulated prices would result in higher forecast accuracy.

The following sub-sections deal in more detail with the identification of the factors underlying forecast non-fulfilment. They are based on the internal documents *Evaluation of Inflation Target Fulfilment* and on situation reports describing the individual forecasts. The sub-sections are further broken down by individual years and their conclusions have been generalised. The following sections also contain figures comparing the actual and assumed development of selected variables at the six-quarter horizon. The horizon moves according to when the relevant forecast was produced. In the case of unobservable variables, such as the output gap or equilibrium trends, the January 2008 estimates are shown. Those estimates were made using the forecasting techniques applied by the Monetary and Statistics Department when preparing the January forecast and are consistent with its assumptions. The manner of identification of the individual unobserved variables in the forecasting process is described in the *Inflation Reports*[5] and in *The Czech National Bank's Forecasting and Policy Analysis System* (CNB, 2003).

3.1 Forecasts published in 2004

The inflation forecasts compiled in this period assume growth in inflation pressures and are higher than the actual outcomes. Thus, they imply a need to raise interest rates that is greater *ex-post* than the path consistent with fulfilment of the target (see Appendix 2). According to these forecasts, inflation was to rise as a result of changes to indirect taxes and regulated prices and their pass-through to inflation expectations. In particular, food price inflation was expected to rise as a result of the tax changes. Moreover, these changes were coming at a time of a turnaround in real economic activity into expansion, with the forecasts predicting sharp growth in the output gap. Moreover, the Monetary and Statistics Department was recommending an interest rate rise and communication to prevent a rise in inflation expectations associated with accession to the EU.

Table 1: Assumed/estimated contribution of tax changes to overall inflation in p.p.

	Q1 2004	Q2 2004	Q3 2004	Q4 2004	Q1 2005	Q2 2005	Q3 2005	Q4 2005	Q1 2006	Q2 2006
January 2004	1	0.26	0.13							
April 2004	0.82	0.29	0.05	0	0.05					
July 2004	0.73	0.19	0.19	0	0.3	0.23	0.02	0	0.21	0.21
October 2004	0.73	0.19	0.19	0	-0.02	0.20	0.24	0	0.27	0.25
Estimate	0.73	0.19	0.5	0.03	0	0	0	-0.2	0.25	0.08

The forecasts for inflation, real economic activity, the exchange rate and thus interest rates did not materialise. This was mainly due to lower impacts of the changes to indirect taxes (see the table above) and to faster growth of the supply side of the economy in the form of faster growth in equilibrium output and faster appreciation of the real exchange rate.

As a result of the lower impacts of the changes to indirect taxes, inflation dropped below the inflation target in 2005 and thus ended up well below the forecast. However, the forecasts in that period assumed significant pass-through effects of the changes to indirect taxes and regulated prices

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[5] For example, the January 2007 *Inflation Report* with the box "The extension of the core prediction model to include the effect of real wages", the October 2005 *Inflation Report* with the box "Potential output in the CNB's forecasting system", and the January 2005 *Inflation Report* with the box "Inflation expectations in the CNB's modelling system".

to inflation via inflation expectations (see Figure 3). In the case of taxes this pass-through was reduced during 2004, but it took some time before the second-round effects in the forecast were fully eliminated. Based on analyses performed in the period under review, the pass-through of energy prices and regulated prices to inflation expectations was lowered in several steps. This had a major anti-inflationary impact on the inflation forecasts.

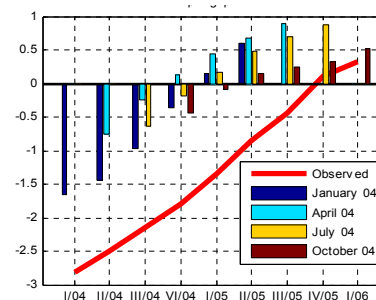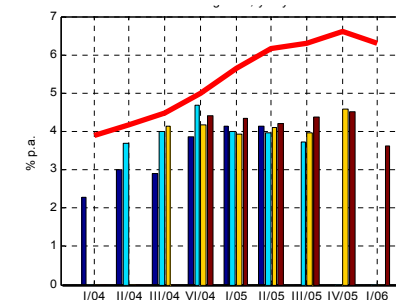**Figure 1: Output gap in %**

Figure 2: Real GDP growth, y-o-y in %

The overvaluation of the forecast was also due significantly to an erroneous projection of the phase of the business cycle (see Figures 1 and 2). The forecasts made at the time correctly expected an upswing in the growth of real economic activity, but rather through growth in demand, i.e. via the output gap. The growth of the output gap in turn implied significant inflationary pressure at the forecast horizon. In reality, however, inflation did not increase at the forecast horizon, even given relatively high observed real GDP growth. This situation is reflected in a change in the contemporary view regarding the development of the output gap. With the benefit of hindsight, we believe that the output gap had an anti-inflationary effect at the forecast horizon. Given the high real growth, there was thus rather an improvement in the supply side of the economy, i.e. faster growth in equilibrium output. In addition, we observed faster equilibrium real exchange rate appreciation.

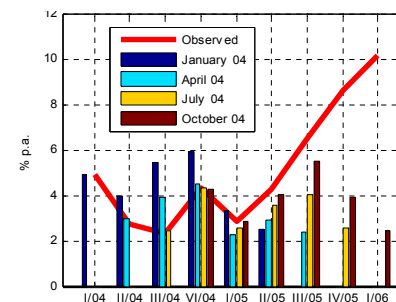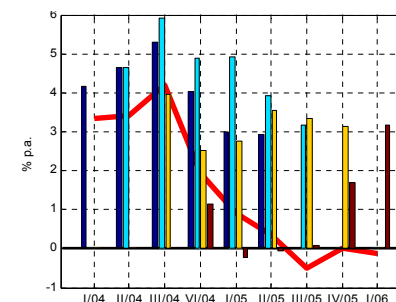**Figure 3: Regulated price inflation, y-o-y in %**

Figure 4: Food price inflation, y-o-y in %

The last significant factor contributing to the forecast error at that time was an *ex-post* incorrect assumption of faster food price growth (see Figure 4). A good harvest, the deferral of a cigarette price hike and, in particular, competition among retail chains kept food price inflation relatively low.

3.2 Forecasts published in 2005

The 2005 forecasts are assessed in relation to the evolution of key macroeconomic variables primarily in 2006. The forecasts for the most closely observed variables, i.e. inflation and interest rates, were fulfilled. The only exception is the final forecast in October 2005, which is well above the outturn. However, if we consider only the first three forecasts that year, their average error is close to zero. There were even forecasts that underestimated inflation.

The fulfilment of the forecasts is consistent with inflation, which was close to the centre of the point target in 2006. Similarly, the evaluation of real economic activity is in line with the contemporary view, although the forecasts for real GDP continued to lag behind the outturns (see Figure 5). Equilibrium output growth (on the supply side) was higher than expected and, as in 2005, correctly assessing and determining the long-term trends remained a problem.
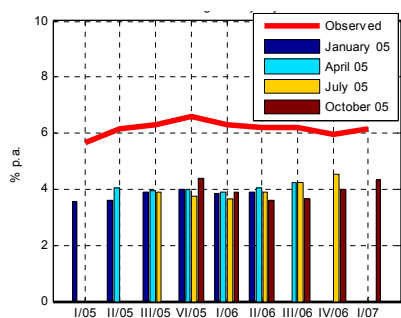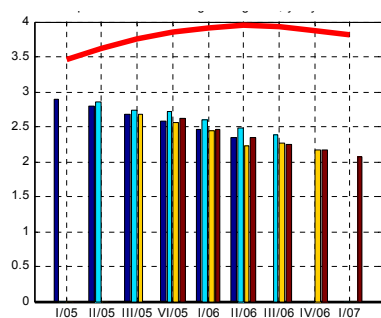
Figure 5: Real GDP growth, y-o-y in %

Figure 6: Equilibium real exchange rate growth, y-o-y in %

The assumptions regarding the evolution of economic activity also had implications for the setting of the real equilibrium exchange rate appreciation (see Figure 6). Although the forecasts from this period may seem to be fully in order, they contain a partial error in the exchange rate forecast. The forecasts again did not expect such a sharp appreciation of the exchange rate. Looking at the overall picture, and as regards the recommendations, the forecasts turned out well, as unexpected growth in regulated prices offset the negative contribution to inflation stemming from a downturn import prices and low food price inflation, which had not been envisaged in the forecast (see Figures 7 and 8).
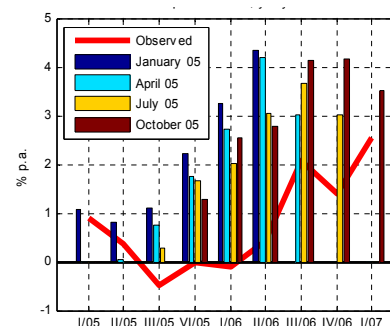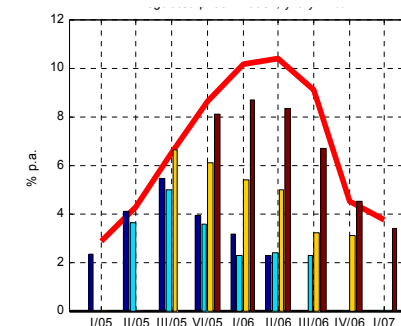
Figure 7: Food price inflation, y-o-y in %

Figure 8: Regulated price inflation, y-o-y in %

The October 2005 forecast is probably the most overvalued forecast in the entire period under review. One possible reason is that this forecast for the first time disaggregated the impacts of the equilibrium real exchange rate appreciation on the components of inflation. It also took into consideration the tradability/non-tradability of each component. Taking into account all of the factors entering the forecast, the overvaluation of the October inflation forecast remains relatively high.

3.3 Forecasts published in 2006

This section only assesses the first two forecasts of 2006, i.e. the January and April ones. At the time of writing, no evaluation had been produced for the remaining forecasts in the form of an *Evaluation of Inflation Target Fulfilment*.

The forecasts from the period under review assumed that inflation would stay close to the point target. In reality, however, inflation dropped significantly in the fourth quarter of 2006 (see Figure 9). In particular, adjusted inflation excluding fuels stayed very low in 2007, while the nominal exchange rate appreciation remained faster than forecasted (see Figure 10).

The nominal exchange rate was thus again the main factor underlying the non-fulfilment of the forecasts. It was accompanied by a significant revision of the impact of changes to indirect taxes on tobacco products. They were substantially lower in 2007 than originally assumed.

The original inflation forecasts, however, are not fully comparable with the observed values, as the weights of the components of the consumption basket, as published by the Czech Statistical Office, were changed in 2007. Observed inflation, retaining the original weights of the CPI basket, remained slightly higher than the actual official data.

Year 2006 can be identified with major changes to the modelling system in historical terms. As mentioned above, the equilibrium variables were revised in order to eliminate their overvaluing effects on the inflation forecasts.
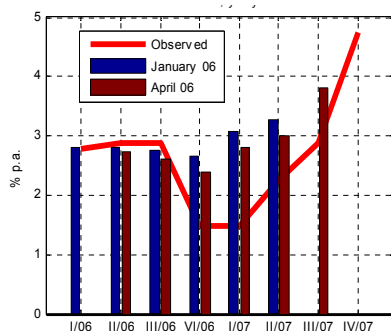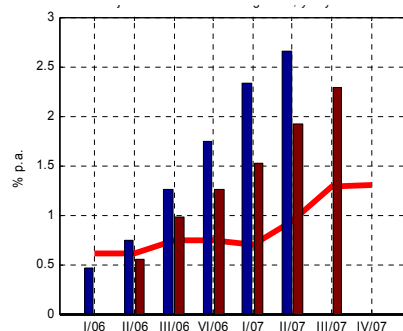
Figure 9: CPI inflation, y-o-y in %

Figure 10: Adjusted inflation exd. fuels, y-o-y in %

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BENEŠ, J., T. HLÉDIK, D. VÁVRA, AND J. VLČEK (2003): "The Quarterly Projection Model and its Properties," In: COATS, W., D. LAXTON, AND D. ROSE, eds.: The Czech National Bank's Forecasting and Policy Analysis System. Prague, Czech National Bank.

THE CZECH NATIONAL BANK'S REPORTS ON INFLATION. Available on-line on: www.cnb.cz.

APPENDIX 1: POINTS OF DEPARTURE AND METHODOLOGY

The CNB's official forecasts are produced by the Monetary and Statistics Division, which is responsible for the development, testing, administration, and operation of the overall forecasting system. Since 2004, the main forecasting tool has been a medium-term quarterly cyclical model of a small open economy, the Quarterly Projection Model (QPM)[6]. This model describes the medium-term linkages between key macroeconomic variables such as inflation, the exchange rate, interest rates and real economic activity. It is primarily focused on the transmission process in an inflation-targeting environment.

The forecasts produced by the Monetary and Statistics Division, however, are not created using the QPM alone. They also take into consideration a host of other information going beyond the scope of the model itself. All this information is integrated into the forecasts following detailed deliberations in quite a long and complex process, with discussions taking place between experts of the Section, with the management of the Section, and with members of the Bank Board and their advisers. This is why these forecasts (unlike the pure model forecasts) are referred to as integrated forecasts.

The CNB's official forecasts are updated on a quarterly basis and are described in detail in the situation reports submitted to the Bank Board as an important reference material for its monetary policy decisions. These integrated forecasts are described as historical forecasts in this text. By comparing them with the actual outturns, we calculate the errors in the historical forecasts.

An internal document *Evaluation of Inflation Target Fulfilment* is produced in parallel with the new forecast. This returns to the forecast created six quarters earlier. It is aimed at analysing in detail the causes of (non-)fulfilment of the inflation target. Since monetary policy-making affects the future, rather than the current, course of inflation, the forecasts – in particular of inflation – are the most important criteria for monetary policy decisions. Consequently, a key part of the *Evaluation of Inflation Target Fulfilment* is an evaluation of the quality of the forecasts, where we strive to identify the sources and pinpoint the causes of any deviations of the original forecasts for key variables from the observed outturns.

The final historical integrated forecast is based on a huge number of differing assumptions and settings, or factors. These factors need to be consolidated into several groups for practical reasons. The appropriate consolidation method depends on the circumstances in which the forecast was made. The most important include the forecasting system and the model version, and also the specific hypotheses we want to test. As a result, the groups of factors in the decomposition of the overall changes in the individual forecasts may differ. When drafting the *Evaluation of Inflation Target Fulfilment*, the historical forecasts created 18 months before are modified to include these factors, grouped most often as follows:

- adjustments made to the modelling system between the creation and evaluation of the forecast;
- the actual development of external variables at the horizon of the original forecast (interest rates, inflation, GDP, oil, USD/EUR cross rate);

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[6] A detailed description of the QPM, along with the CNB's forecasting and analytical system, is contained in *The Czech National Bank's Forecasting and Policy Analysis System* (CNB 2003).

- new estimates of the equilibrium variables at the horizon of the original forecast (domestic and external real interest rates, real exchange rate appreciation, risk premium, non-inflationary domestic and external output growth, real wage growth);
- the actual impact of changes to indirect taxes at home and abroad at the horizon of the original forecast;
- new assumptions about the effect of fiscal policy on the real economy at the horizon of the original forecast;
- the actual development of regulated prices at the horizon of the original forecast.

Those factors enter the forecast creation process as exogenous variables and monetary policy cannot influence them. However, since they are important for future inflation, assumptions about their evolution are made or forecasted using information from other institutions.

Our methodology applies the core QPM to break down the overall deviation in the forecast according to the effects of the individual groups of factors – artificial forecasts are simulated based on various assumptions about the development of these factors. Unlike with the creation of the forecast proper, replication of the actual forecasting process using various techniques, models and expert knowledge to evaluate the effects of each group of factors is practically impossible and the simulation is performed in a mechanical manner. The results, therefore, must be interpreted with great caution, taking into account the actual content of the relevant historical forecast.

In practice, the evaluation of the impact of the individual groups of factors on the forecast is performed by means of model simulations in which more and more groups of updated factors are added. The method of cumulative changes is thus used. We start with the original historical forecast and incorporate changes in the factors group by group until all of the factors have been fully updated. Under this approach, the effect of changes to a group of factors depends on the changes to the factors made in the previous simulations. Therefore, the sequence of the changes is important when evaluating their impact on the forecast.

By incorporating the changes to all relevant factors into the historical forecasts we arrive at the adjusted (integrated) forecast. The difference between the adjusted forecast and the outturn is referred to the adjusted forecast error.

To express the aforementioned methodology more formally, the forecast of any variable F is a function of a vector of factors (or information subsets) $z = (z^1, \ldots, z^n)$ which form the complete information set used to make the forecast: $F(z)$. The contributions K to the change in the forecast pertaining to the changes in the groups of factors are then:

$$\Delta F = F(z_1) - F(z_0) = \sum_{k=1}^{n} K_k,$$

where $z = (z_i^1, \ldots z_i^n)$, $i = 0,1$, with subscripts 0 and 1 denoting the original and updated information subset for the individual groups of factors. $F(z_0)$ therefore denotes the original historical forecast and $F(z_1)$ the resulting adjusted forecast.

Let us assume that the groups of factors are indexed according to the order in which they are updated in the simulations. If we use superscript $-k$ to denote the vector of all variables except the variable with the k-th superscript, we get the following equation for the change in the prediction for variable F:

$$\Delta F = F(z_1^1, z_0^{-1}) - F(z_0) + F(z_1^1, z_1^2, z_0^{-1,2}) - F(z_1^1, z_0^{-1}) + \ldots + F(z_1) - F(z_1^{-n}, z_0^n) = \sum_{k=1}^{n} K_k,$$

where

$$K_k = F(z_1^1, \ldots, z_1^k, z_0^{k+1}, \ldots, z_0^n) - F(z_1^1, \ldots, z_1^{k-1}, z_0^k, \ldots, z_0^n).$$

The advantage of the cumulative approach to evaluating the effect of groups of factors on the forecast is that the quantitative impact of the changes in the individual factors sums exactly to the overall change in the forecast without any need to linearise the model. The disadvantage is its above-mentioned dependence on the order of the simulations, which means that the decomposition is not clear and thus makes it more difficult to interpret the results.

From the practical point of view, it is better to start off the decomposition with simulations assessing the impact of changes in the most non-linear factors, such as changes in the modelling system, and then continue with factors whose changes – given the model used – are linear or "almost linear". For subsequent determination of the order, it is more sensible to replicate the order used during the creation of the original forecast, where – for example – the estimate of the domestic initial conditions depends on assumptions regarding external developments.

In seeking the causes of (non-)fulfilment of inflation targets, the adjusted forecasts are objectively a better source of information than the historical forecasts because they are based on the actual development of factors exogenous to monetary policy. The adjusted forecast error eliminates from the original historical forecast error the part which pertains to the deviation of the forecasts for exogenous variables from the outturn. Therefore, the core elements of the adjusted forecast error are:
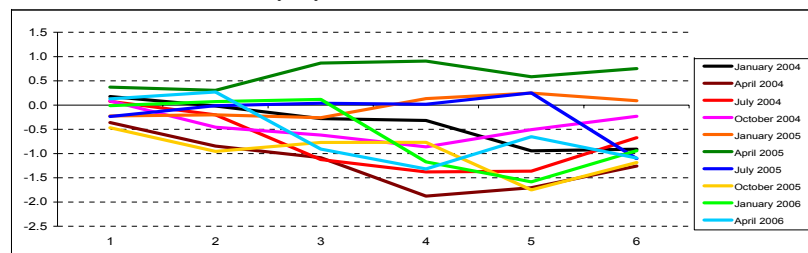
- the omission or incorrect description of key economic processes in the modelling system;
- imperfect capture of ongoing changes in economic elasticities or linkages;
- erroneous *ex-post* identification of economic shocks affecting the economy, leading to incorrect determination of the initial assumptions of the forecasts;
- unexpected economic shocks causing deviations of inflation and other economic variables (in the event of certain unexpected strong shocks, fulfilment of the inflation target is in fact objectively unrealistic);
- adjusted forecast errors also include monetary policy errors (not only in interest rate settings, but also in correct communication of monetary policy to the public).

Yet another factor affecting the size of the adjusted forecast errors is the way in which the *ex-post* model simulations are performed to quantify the effects of deviations of the forecast assumptions from reality. Those simulations assume that the expected evolution of exogenous variables was exactly equal to their *ex-post* observed values. In reality, however, the information set of economic agents changes over time, resulting in a gradual revision of expectations in line with new shocks. Executing all the historical model simulations based on the new information sets in each quarter would be so time-consuming in the current modelling system that it would exceed the time frame of the present study.
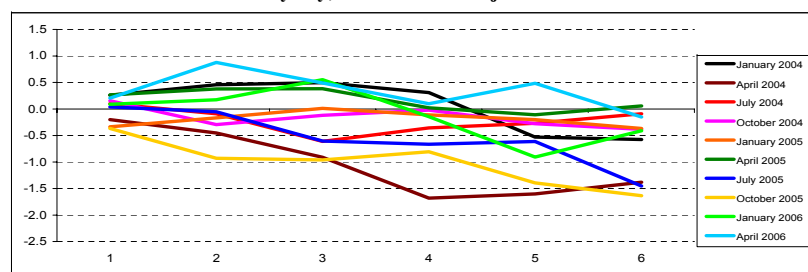
APPENDIX 2: DEVIATIONS OF THE FORECASTS FROM REALITY

FORECASTED AND ACTUAL INFLATION

Inflation y-o-y, Deviations of historical forecasts

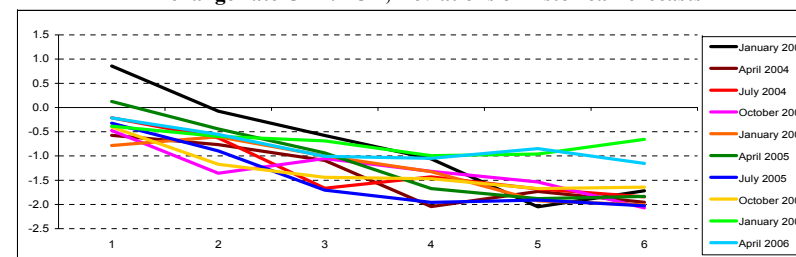**Inflation y-o-y, Deviations of adjusted forecasts**

For the inflation forecasts, a relatively good predictive ability can be identified in the first two to three quarters, when the errors of both the historical and adjusted forecasts are close to zero with small standard deviations. As for the forecasts from four to six quarters, the means of both forecasts become more negative. The standard deviation rises in the fourth quarter, but remains almost constant for the rest of the forecast. This is connected with increasing future uncertainty and also with the unconditionality of the forecasts.

The historical forecast deviation chart shows that inflation forecasts deviate slightly upwards, particularly at the end of the forecast horizon. However, the adjusted forecast deviation chart does not show that the inflation estimate deviates systematically over the entire forecast horizon – there are forecasts that are lower than actual inflation and fluctuating around the outturn. In addition, one can identify adjusted forecasts that are higher than the outturn over the entire horizon (the April 2004 and October 2005 forecasts). Despite some deviations, the adjusted forecasts are capable of capturing the dynamics of the development and changes in overall annual inflation.
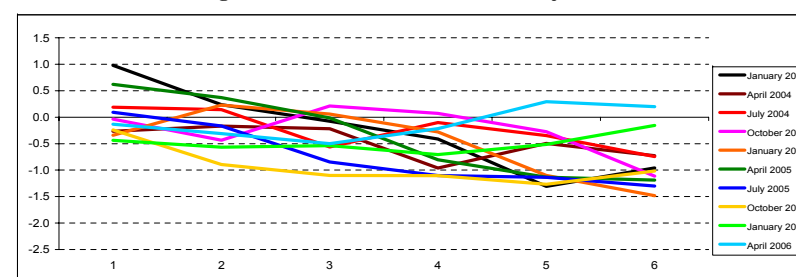
In terms of the size of the integrated forecast error, the April 2004 and October 2005 forecasts can be regarded as the least successful. If we remove those forecasts, we get a significant reduction in the negative deviation (as measured by the mean forecast from the second quarter of the prediction) and a reduction in the standard deviation for both the historical and adjusted forecast errors.

FORECASTED AND ACTUAL EXCHANGE RATE

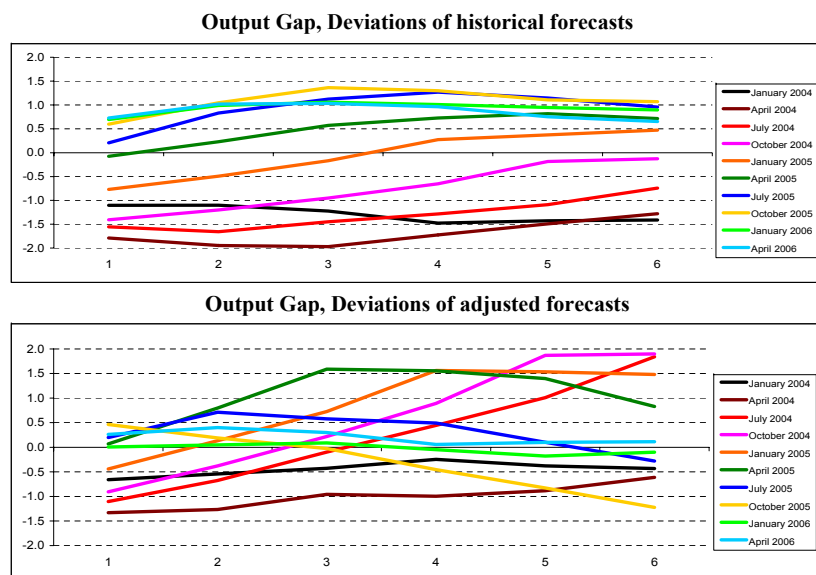**Exchange rate CZK/EUR, Deviations of historical forecasts**

Exchange rate CZK/EUR, Deviations of adjusted forecasts

In all the observed historical forecasts, the forecasted exchange rate appreciation deviated unilaterally from the outturn, or – more accurately – the observed rate of appreciation of the nominal CZK/EUR exchange rate was systematically higher than we expected. The largest average difference occurs between the third and the fourth quarter forecasts. In subsequent quarters it declines slightly. The adjusted forecasts show a significant reduction in errors over the entire horizon under review. The adjusted forecast error chart surprisingly shows significant growth in both the average error and the standard deviation for the fifth quarter of the forecast.

A comparison of the actual outturns and the adjusted forecasts reveals that the forecasts are capable of capturing changes in the rate of appreciation, but are not able to estimate the size of that rate. The latter was significantly higher in reality. The exchange rate forecasts were significantly affected by the assumptions made about the equilibrium real exchange rate appreciation paths and the equilibrium real interest rate levels.

FORECASTED AND ACTUAL OUTPUT GAP

Output Gap, Deviations of historical forecasts

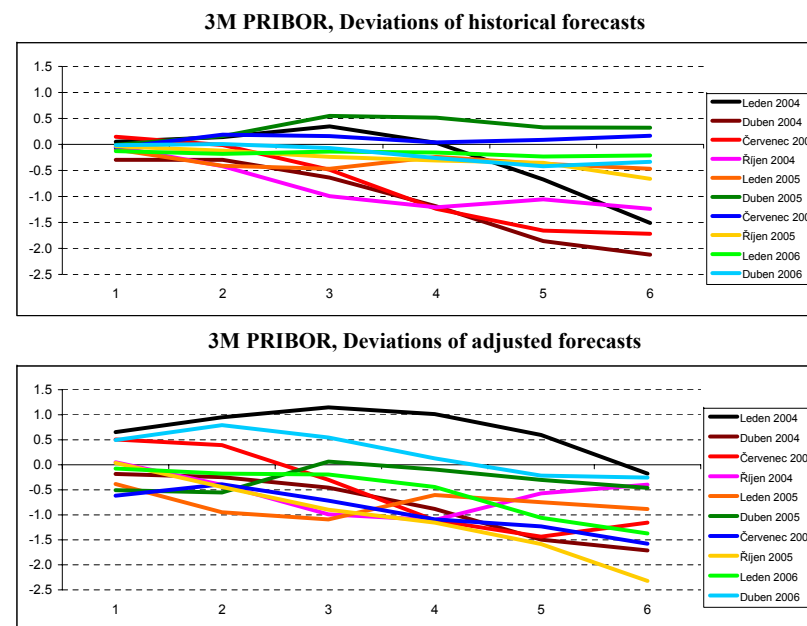**Output Gap, Deviations of adjusted forecasts**

Analysing the output gap is more difficult because we do not know its actual course. We only have more recent estimates, which we believe better reflect the true phase of the business cycle. The output gap now represents the inflation pressures arising from production costs and is one of the two components of real marginal costs. The other is the real wage gap.

The historical forecast deviation chart shows only a moderate downward diversion of the average deviations. The forecast is, therefore, slightly higher than the actual estimate. Ignoring the less successful forecasts in terms of inflation (the April 2004 and October 2005 forecasts), the average forecast error is even lower, while the standard deviation is roughly constant. A comparison of the historical forecasts with the current view regarding the development of the output gap reveals that the forecasts produced until the first quarter of 2005 are above the current estimate of the output gap. In the subsequent period, the forecasted output gaps are mostly lower than the current estimate.

More valuable information is offered by the adjusted forecast analysis. A comparison of the paths of the individual forecasts (excluding the least successful ones) gives a positive mean error. The slower closure of the output gap results from a restrictive fiscal effect in 2004 and 2005 and, on the contrary, an expansive effect in 2006.

FORECASTED AND ACTUAL INTEREST RATE

3M PRIBOR, Deviations of historical forecasts

3M PRIBOR, Deviations of adjusted forecasts

Evaluating the deviations of nominal interest rates from the outturns is no easy task. As mentioned above, monetary policy is endogenous to the forecasting framework and responds to the inflation forecast. Therefore, it works solely with the information contained in the reviewed forecast. In reality, the historical path of rates reflects a gradual process of adjustment to new information and shocks.

As far as errors relating to historical forecasts of interest rates are concerned, there is a clear trend towards negative deviation starting with the second quarter of the forecast. This fact is confirmed by the chart showing the adjusted forecast deviations. Most of the forecasts are higher than the actual interest rates over the entire forecast horizon. This is consistent with the higher inflation forecasts, as higher inflation pressures at the forecast horizons implied a need for a greater tightening of interest rates.

The higher negative deviations of the historical forecasts, especially in the 2004 and 2005 forecasts, were probably influenced by the – from the current viewpoint – incorrect settings of certain model equilibria. The path of equilibrium real rates was at that time assumed to be at higher levels than the economic reality, which meant a higher politically neutral interest rate and consequently also a higher implied path of monetary policy rates. The politically neutral interest rate in this case acts as the equilibrium rate to which the forecasted rate converges (this effect manifests itself at the forecast horizon).