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EDITORIAL

Viewed from the outside, inflation targeting involves the central bank regularly producing an inflation forecast, comparing the forecast outcome to the target, and adjusting interest rates accordingly. However, there is more to the inflation-targeting process than meets the eye.

Sub-optimal policy interest rates can be costly for the economy, and hence central bankers pay attention not only to the formal forecasting process itself but also to various strategic issues and uncertainties related to the forecast.

This issue of the CNB Research Bulletin begins with an outline of the forecasting model currently used by the CNB, including efforts aimed at its extension (Jaromír Beneš, Tibor Hlédik and David Vávra).

Kateřina Šmídková goes on to present various methods of dealing with forecast uncertainty.

Michal Skořepa then discusses the ways central banks' future interest rates can be incorporated in their projections of future economic developments.

And finally, Viktor Kotlán evaluates the relevance of using simple indicators, such as the yield curve, in the process of inflation targeting.

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IN THIS ISSUE

Developing macroeconomic models for inflation targeting[1]

Jaromír Beneš, Tibor Hlédik and David Vávra *

The CNB introduced an inflation-targeting (IT) regime in January 1998. By targeting consumer price inflation four quarters ahead instead of reacting to actual inflation, the policy was intended to smooth economic cycles and overall inflation to a substantial degree.

Since 1998, considerable progress has been made not only in developing various types of formalised forecasting and analytical tools, but also in closely integrating them into the decision-making process.

Before IT was introduced – and even during the early stages of applying IT – the CNB's forecasting framework consisted, as with many other central banks in transition economies, of numerous small, typically single-equation-based estimated models.

These econometric equations served as short-term forecasting tools mainly for supporting expert-based forecasts.

The whole forecasting process was time-consuming and not sufficiently instructive or intuitive in terms of the ultimate message. It was extremely difficult to achieve consistency between the theoretical assumptions underlying the large number of individual models.

One must admit that there was almost no role for monetary policy in these projections, and therefore it was impossible to analyse any alternative risk-scenario relative to the baseline projection.

Because of this, demand-side effects (conditional mainly on monetary and fiscal policies) were not captured fully in the forecasting process; cost-push factors, by contrast, were dominant.

Given the lack of a simultaneous model structure, these forecasts could not capture the forward-looking, model-consistent expectations of economic agents.

This is also why they could not appropriately account for the expectation channel, which is critical in small open economies.[2]

As a consequence, the forecasting process put too great an emphasis on recent and current information.

In addition, these projections had not worked with any long-term structure and it was never clear to what equilibrium state the economy actually converged in the long run.

The Quarterly Projection Model (QPM) was introduced by the CNB in June 2001.[3] It currently serves as the core forecasting- and policy-analysis model and addresses most of the above-listed weaknesses of the system previously applied.

The model is highly aggregated and accounts only for the main behavioural relationships of the Czech economy. Nonetheless, it is able to capture the forward-looking, model-consistent expectations of economic agents. This feature is important for more realistic modelling of variables such as the nominal exchange rate and long-term interest rates.

The QPM converges to a well-defined steady state, although this simply derived equilibrium does not provide too much detail nor microeconomic foundation.

The model's dynamic properties are significantly influenced by the chosen policy rule.

The output gap – the most important indicator approximating demand pressures – is influenced by monetary policy through both the real exchange rate and real interest rate channels. (The Kalman filter, applied for a simultaneous equation setting, is used for determining potential output in the model.)

The results obtained from alternative models are incorporated into the core model in a consistent manner.[4]

The whole forecasting process is documented in great detail; the

[1] The present article is based on Beneš, Hlédik and Vávra (2003), forthcoming as a CNB Working Paper.
[2] See Beneš, Vávra and Vlček (2002) for a discussion of this issue.
[3] See Coats, Laxton and Rose (2003) for more on the key properties of the QPM.
[4] Short-term forecasts from alternative models, more detailed forecasts of the individual items in the national accounts, expert judgements, and leading indicators are incorporated into the medium-term model forecast for the first two quarters of the forecast horizon.
[5] For a representative collection of papers see for instance Brian Doyle's webpage (http://www.geocities.com//brian_m_doyle/open.html).

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validity of each input into the forecast is regularly evaluated later on; and this feedback is utilised for further improvements to the overall projection process.

As mentioned earlier, the QPM is highly aggregated and unable to forecast the most important parts of the national accounts consistently. No model-consistent, stock-flow equilibrium can be derived.

In addition, it is impossible to differentiate between the tradable and non-tradable sectors. Given the lack of microeconomic foundations in most model equations, no change in the microeconomic characteristics of the economy can be traced.

Due to the simplicity of the QPM, its steady-state version is obviously not supported by a deeper structure.

To sum up, we need much more detail, sound microeconomic foundations, and full stock-flow equilibrium.

Our ongoing research is aimed at developing a new stochastic dynamic general equilibrium (SDGE) model for the Czech Republic.

We are inspired by the recent New Open Economy Macroeconomics (NOEM) literature.[5]

This approach makes is possible to generate the real medium-term effects of monetary policy in a more realistic manner.

All the key items in the national accounts, such as consumption, investment, inventory demand and trade balance, are consistently derived with respect to the relevant budget constraints of households, firms or government.

Price and wage developments are based on the optimising behaviour of firms and households, including the motives underlying the nominal-price and wage inertia observed. Including the tradable and non-tradable sectors in the model makes it possible to analyse the determinants of real exchange-rate appreciation.

Such a structured and detailed model enables us to deepen the analysis of policy issues with respect to a well-defined equilibrium path for the Czech economy.

First of all, we have in mind policy issues such as assessing the impact of the shift in productivity parameters or of changes in the tax structure on the economy. Moreover, we are better able to interpret changes in the accumulated capital stock, private and public wealth, debt structure or relative prices.

Assuming imperfect competition on most markets, even structural issues such as the degree of competition and its impact on relative prices or equilibrium unemployment can be analysed.

In particular, our preliminary impulse-response results suggest that we are able to generate plausible patterns of cyclical behaviour that are in line with both our intuition regarding the functioning of the Czech economy and simulation results obtained by the QPM.

As far as practical applications are concerned, the new model has been used for assessing the implications of recent changes of indirect taxes on the inflation pattern of the Czech economy.

In conclusion, we believe that the new model, given the structure and detail it can provide, should further facilitate the already very open communication between the Czech National Bank and the general public. ■

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Inflation targeting under uncertainty: a policy-maker's perspective[1]

Kateřina Šmídková *

With inflation targeting, the quality of monetary-policy decisions depends on the ability of policy-makers to set interest rates in line with the inflation forecast.

Poor assessment of uncertainties related to the forecast can be quite costly.[2] Hence, a theory-based forecasting model and a consistent scenario for exogenous variables need to be complemented by an assessment of forecast uncertainties.

Central bankers must be able to detect the key uncertainties related to the model and its assumptions, evaluate their implications for the inflation forecast, and assess how likely alternative outcomes are.

Only then is it possible to determine the expected path for inflation. Neglecting one of these steps is likely to result in interest rates that are to too high, too low, or too rigid in relation to what the economy requires.

Policy-makers routinely take complex uncertainties into account when making decisions about interest rates. The examples of oil-price fluctuations, international financial-market volatility, or the implications of EU enlargement are worth mentioning in this context.

Policy-makers need to realize, however, that while it is important to assess all types of uncertainty, uncertainty as such cannot be fully modelled. Hence, policy-makers need to use a combination of various methods and rely on quantitative analysis, as well as on expert judgment and intuition.

With the increase in the number of central banks using the inflation-targeting regime in the 1990s, academic research began to focus more on the complex assessment of uncertainty instead of analyzing the implications of easily represented risks.[3]

Our survey is organized around the key components of the decision-making process and the corresponding methods of addressing uncertainty (Table 1).

We note that the variety of methods used by central banks to deal with uncertainty is striking and that real-life strategies are very different from the world of model-based inflation-forecast targeting.

Policy-makers may employ, among other methods, the "mistake-proof" approach to dealing with uncertainty, in which they ask experts to present as many types of uncertainty as possible and, in addition, reduce mistakes in the judgments of individual experts by employing consensual decision-making techniques.

This approach is technically demanding and time-consuming. Therefore, policy-makers can decide to minimise the costs by working with uncertainty only implicitly or relying on the intuition of just one decision-maker.

Alternatively, policy-makers can combine the above approaches, i.e., stay in the middle-ground.

In addition to the methods presented above, policy-makers can find inspiration in recent academic literature as well as in the managerial strategies of other decision-makers.

Regarding the former, academic researchers have come up with robust control, Bayesian fan charts, and alternative forms of quantifying uncertainty.[4]

Regarding the latter, when it comes to incorporating expert

[1] The present article is based on Šmídková (2003). See http://www.cnb.cz/en/pdf/IRPN_2_2003.pdf for a full version of this CNB Research and Policy Note.

[2] The pioneering study by Brainard (1967) gives a good example of what happens if uncertainty is neglected and demonstrates that policy-makers need to be cautious when faced with uncertainty, as opposed to full certainty, about the underlying model.

[3] Explanations of the various approaches available to monetary-policy-makers have been provided by Hunt and Orr (1999). Policy-makers might also refer to Knight (1921), who distinguishes between risks and uncertainties. Risks are easy to represent in the model whilst uncertainties are difficult to represent ex ante with a simple probability distribution.

[4] The Bayesian fan chart has been developed for the UK by Cogley, Morozov and Sargent (2003). Discussion of the proper design of robust control can be found in Sims (2001). Alternative representations of uncertainty are discussed by Wallis (2003).

[5] For the basics of decision analysis see Clemen (1996). In addition to quantitative methods that are very similar to those used by economic researchers, methods based on subjective judgment are also discussed here. Academic researchers have recently demonstrated that monetary-policy decisions taken by a group of experts are superior to decisions taken individually. The link between managerial methods and the voting of the monetary policy committee can be found in Lombardelli, Proudman and Talbot (2002).

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judgment and intuition into the decision-making process, decision analysis can offer various techniques to prevent bias in subjective judgements.

For example, the common failing of "wishful thinking" can often lead to using the wrong set of assumptions for the inflation forecast. Delphi method, which require the group of experts to reach consensual decisions or average the views across the group, are among the most popular methods of preventing bias of this type.[5] ■

TABLE 1: Methods available to monetary-policy-makers

Methods used/Components of the decision process	The mistake-proof approach	The middle-ground approach	The cost-saving approach
Forecasting system is based on	stochastic/Bayesian model researchers	core deterministic model five central banks	expert judgement central banks in the past*
Alternative sets of assumptions are presented by	probability distribution two central banks* researchers	benchmark & alternatives five central banks researchers	several alternatives one central bank* researchers
Probabilities of alternative sets are formulated by	group consensus two central banks* decision-makers	experts, then averaged one central bank* decision-makers	implicitly five central banks
Results of alternative outcomes are evaluated by	event probability researchers	loss function three central banks* decision-makers	implicitly five central banks
Decision about interest rates is reached by	consensus of the board one central bank decision-makers	voting of the board three central banks decision-makers	governor one central bank decision-makers

NOTES: The five rows summarise the basic components of the monetary-policy decision-making process. The three columns correspond to the basic methods used to deal with uncertainty. A short description of the alternative methods is given for each component. In addition, for each component it is indicated whether the method concerned is applied by central banks (yellow), and, if so, by how many of them. Methods used only partially by central banks are marked with an asterisk (*). Also marked for each component are those methods (not yet utilized by central banks) that have been proposed by researchers (green) or used by decision-makers in other important institutions (blue). The central banks surveyed are the Bank of Canada, the Bank of England, the Czech National Bank, the Reserve Bank of New Zealand and the Swedish Riksbank.

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Inflation targeting: To forecast or to simulate?[1]

Michal Skořepa *

Central banks operating under a regime of inflation targeting base their decisions on projections of future economic developments. Such projections must in some way incorporate the behaviour of major economic agents, including the central bank itself.

Whether the projection is constructed using a formal model or is more judgement-based, the central bank's own future behaviour can be incorporated in two basic ways.

First, certain aspects of a central bank's behaviour can be assumed, but without claiming that they are the most likely form future behaviour will take.

For instance, projections can be based on an assumption of constant interest rates, regardless of the actual behaviour of inflation or the economic cycle. Such a projection is a "simulation", answering just one question: "What would happen should interest rates stay constant?" In reality, however, interest rates will most likely move.

Second, a central bank can actually try to predict its own future behaviour. This is what central bankers typically label a "forecast".

A central bank's behaviour is usually treated using the so-called "policy rule" (sometimes called a "reaction function"), a simple rule which approximates the movements of policy interest rates as a function of several key variables. In practice, central banks use both forecasts and simulations (Table 1).

The choice of projection – simulation or forecast – has implications for other agents in the economy. Given that forecasts – unlike simulations – give a probable picture of the future, they are appreciated by all those who cannot afford to produce their own macroeconomic forecasts.

At the same time, "forecasts" are more attractive for the media when they want to report on the central bank's outlook or compare it with the forecasts produced by other institutions or analysts.

But, from the central bank's viewpoint, the choice between these two approaches is not so easy – both have their pros and cons. These can be found on three levels: (i) the projection's construction; (ii) its use as a basis for monetary-policy decision-making; and (iii) its use in communications with the public.

On the level of construction, simulations are subject to a version of the Lucas Critique. The formal or judgment-based models on which the simulations are founded describe the actual economy, where all agents (including the central bank) have up to now behaved in roughly the usual ways.

By contrast, the point of simulation is to study how the economy would react if the central bank behaved in other than the usual way (for example if it kept its rates constant regardless of inflation developments).

As Lucas (1976) argued, it is beyond the power of most models and forecasting tools to capture the change in the behaviour of all agents in the economy, should one of the agents (i.e. the central bank) change the way it normally behaves.

The construction of forecasts, however, has drawbacks of its own. Specifically, one needs an idea of the most likely future behaviour of the central bank, and this is far from easy to predict (Vickers, 1998).

On the level of actual monetary-policy decision-making, simulations give only qualitative guidance to the policy-maker. They show how inflation is expected to differ from the target in the future (for example, given no change in policy rates), but do not show what the central bank needs to do to ensure that inflation gets back to the target within a specified time period.

This "advice" has to be supplemented by a judgement on the appropriate strength of the change in interest rates.

With forecasts, on the other hand, policy-makers can feel "locked up" in the forecasted trajectory. Once a forecast has been approved, policy-makers are forced into a defensive position where they have to find very strong arguments if they wish to change the forecasted trajectory of interest rates.

Regarding the communication aspects of monetary policy, the advantages of forecasts are clear: they show what is most likely to happen.

On the other hand, simulations that are based on a possibly unrealistic assumption about the central bank's behaviour can prove difficult to digest by most of the public.

[1] The present article is based on Skořepa and Kotlán (2003). See http://www.cnb.cz/en/pdf/IRPN_1_2003.pdf for a full version of this CNB Internal Research and Policy Note.

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Apart from being easier to understand, forecasts may assist in anchoring expectations at times when the central bank admits the inflation target will be missed. Obviously, simulations cannot serve this purpose. They are constructed to answer the "what if" type of question.

A frequent objection to the forecast as a communication device is that the markets and the public in general may (incorrectly) perceive a commitment on the part of the central bank to follow the forecasted trajectory of interest rates in the future (e.g. Goodhart, 2001).

In this respect, it is useful to study the experience of the CNB which – after a thorough evaluation of all arguments – decided to move from simulation to forecast in July 2002.

Looking at developments on the capital markets from July 2002 onwards, one can infer that the CNB has probably succeeded in explaining to the public that the forecast is conditional on current information and thus that future policy steps may deviate from the forecast.

This shows that the commitment problem may not necessarily materialise in practice.

To conclude, it is not a straightforward exercise to predict one's own future behaviour. This is certainly true for central banks, which struggle with the difficulties of dealing with themselves in their outlook for the future, no matter which of the two approaches described above they take. ■

TABLE 1: How the future is assessed by some inflation-targeting central banks

Type of assessment	Simulation assumes	Examples of countries	Published trajectory of	
			IR	ER
Simulation	constant IR and ER	Australia, Hungary, Norway	constant as assumed	
	constant IR	Chile	constant as assumed	EER index at end of forecast
		Sweden	constant as assumed	yearly averages of EER
		UK	constant as assumed	quarterly average of EER at end of forecast period
Forecast		Canada	none	none
		Czech Republic	basic shape verbally	basic shape verbally
		New Zealand	quarterly averages of 3MIR	half-year averages of EER rounded to integers

SOURCE: websites or official publications of the respective central banks available in spring 2002.
NOTES: IR = interest rate, ER = exchange rate, EER = effective ER, 3M = 3-month.

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Should central banks look at the yield curve when using an inflation-targeting strategy?[1]

Viktor Kotlán *

The yield curve, a graphical representation of the term structure of interest rates, represents one of the most useful figures central bankers look at.

The shape of the yield curve summarizes both current short rates and expected future short rates since long-term interest rates are formed on the basis of expected future short-term interest rates.

(Figure 1 illustrates the developments of the money market yield curve between the April and May 2004 CNB bank board meetings when markets revised the expected future path of short-term interest rates.)

In other words, the curve contains information on expected future movements of short-term rates. And since these short-term rates are heavily influenced by the central bank's rates, forming a view on today's long-term rates in turn means forming a view on future actions by the central bank.

This, by itself, would probably suffice as a reason to look at the yield curve. But is there more than that to learn from the yield curve?

According to a relatively large body of mostly empirical literature, there is (see the references for some examples). The authors of these studies argue that the shape of the yield curve is a useful indicator not only of future short-term rates, but also of future inflation and/or future real economic activity.

They maintain that an upward-sloping yield curve suggests that the market expects the rate of inflation to pick up in the future and/or that the rate of economic growth will increase. The opposite holds when the yield curve is sloping downwards.

If this were true, then the yield curve could also serve as an indicator of future inflation/economic activity. Even though it could not fully replace the role of structural models in monetary policy decision-making under inflation targeting, the yield curve still could play a useful role in checking forecast consistency.

Our research is thus aimed at examining the indicative properties of the yield curve in the Czech Republic. Unlike most of the literature, however, we refrain from the usual single-equation approach and turn to a more theoretical way of modelling the problem.

Why is it worth replacing the single-equation approach with a closed model? Suppose a central bank whose only objective is to keep inflation at the level set by its inflation target uses a certain variable called X as the only indicator of future inflationary pressures.

Further, suppose that a positive X indicates future inflation above the target and negative X indicates future inflation below the target. Since the bank's goal is too keep inflation on target, it will – based on what the indicator suggests – take measures that ensure the target is reached in the future.

If X is used for monetary-policy design and the policy is successful, what will we ultimately see in the data? Most likely, we will see that while X has moved around, inflation has stayed at the target level.

This is why reduced-form econometric techniques, including the single-equation approach, might lead to a false conclusion that there is no relation between indicator X and (lagged) inflation.

Closed-model techniques taking into account the interrelationships between variables such as economic activity, inflation or expected inflation and the role of monetary policy are better-suited to answer such questions.

These techniques not only circumvent the problem described above but also avoid the problems of the short time-series available for the Czech economy, which would not necessarily lead to robust empirical results.

Initially, we construct a simple forward-looking gap model along the lines of the Czech National Bank's QPM model (see Coats, Laxton and Rose, 2003) and then conduct multiple simulations.

These are designed using a set of demand, supply and exchange rate shocks to examine the rela-

[1] The present article is based on Kotlán (2002). See http://www.cnb.cz/en/pdf/wp_1.pdf for a full version of this CNB Working Paper.

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tionship between the term-spread on the one hand and economic activity, inflation and other important macroeconomic variables on the other.

We show that the indicative power of the term-spread is dependent on the way monetary policy is conducted. As a result, the indicative power of the yield curve is not simply applicable to any chosen monetary-policy regime.

Specifically, we argue that the term-spread's indicative power with regard to future inflation (real economic activity) depends positively on the relative weight which the central bank assigns to inflation (real economic activity) stabilisation in its reaction function.

In other words, what the yield curve indicates is a function of what the central bank is focused on.

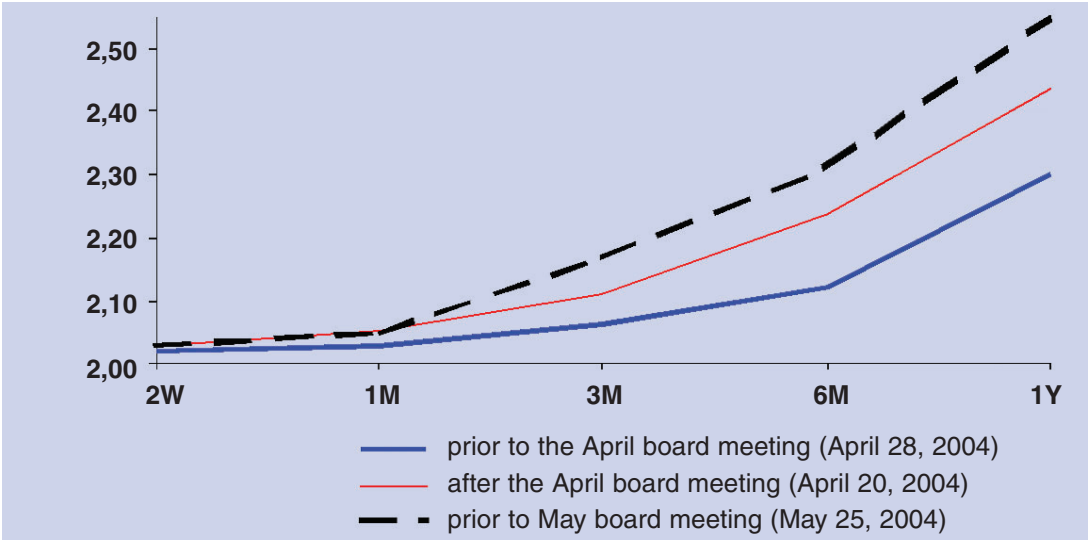
If the relative weight of the variables in question is high, then the yield curve may prove useful. On the other hand, if the central bank focuses not only on inflation but also on other variables, such as cyclical developments per se, then the indicative power of the yield curve for any of these variables is hampered.

Our results confirm that the role of simple indicators in the inflation-targeting regime, such as the term-spread, is limited.

Indeed, proper monetary policy that uses an inflation-targeting strategy must be based on structural models since these are much better at capturing the rich dynamics of economic variables than the shape of the yield curve itself.

However, this is not to dispute the fact that the yield curve remains an important tool. After all, who would not like to know what others think about what one is going to do in the future? ■

GRAPH 1: The Czech Money Market Yield Curve (April 28 – May 25, 2004)



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