CHAPTER 8

THE HISTORY OF INFLATION TARGETING IN THE CZECH REPUBLIC THROUGH OPTIC OF A DYNAMIC GENERAL EQUILIBRIUM MODEL

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1. INTRODUCTION

The inflation targeting regime was effectively introduced by the Czech National Bank (CNB) from January 1998. While, during the first six months of that year, inflation had been staying at the values above the first inflation target published for the end of the same year, it then dropped well below the target during autumn 1998 and CNB subsequently undershoot also its targets declared for year-ends of 1999 and 2000. The first actually hit inflation target was that for the end of 2001. Even introduction of the continuous target since January 2002 failed to bring any clear improvement in its effective fulfilment. Holub and Hurník (2008) report that from January 2002, when the continuous target was introduced, till the end of 2007, inflation moved below its midpoint for some 90% per cent of the period and even below its lower tolerance interval for 51% of the time.

The Czech economy was not the only one among the developing economies that experienced disinflation following introduction of the inflation targeting regime[1], but was probably the only one where inflation moved below the declared inflation targets most of the time once the inflation targeting regime has been introduced. Undershooting of inflation targets was undoubtedly due to many reasons and this paper does not attempt to identify all of them. Instead, it discusses in more detail only one of the possibilities. Or, to put it more precisely, it strives to describe the role that may have been played by monetary policy itself.

Using a dynamic general equilibrium model we therefore analyze monetary policy with respect to its publicly declared inflation target. We base ourselves on a simple assumption that monetary policy may be essentially analysed only with the help of an economic model that itself contains monetary policy, while it holds at the same time that parametrisation of such economic model is independent of monetary policy (Lucas, 1976).[2] A structural economic model, encompassing the central bank behaviour and certain sets of observed economic variables, should be therefore used in order to understand historical development of monetary policy properly. Both the economic model and set of observed economic variables are then used to estimate economic (structural) shocks, including also the monetary policy shock. The heart of the method used thus consists in explaining, with the help of the economic model, the observed dynamics of the economic variables by economic shocks. Such shocks will include e.g. changes in technology, consumer preferences, exchange rate shocks and, also, monetary policy shocks.

Apparently, the course of monetary policy shocks and their impact on the nominal interest rates and inflation are of main interest if monetary policy is evaluated. If any part of the observed realization of nominal interest rates is to be attributed to a monetary policy shock, we conclude that the central bank set the interest rates either above or below the level that would be consistent with the observed state of the economy and published inflation target. An error in monetary policy setting (i.e. a monetary policy shock) occurs whenever the central bank misinterprets the observed state of economy, or, sets the interest rates otherwise than would be consistent with the observed state of economy and inflation target.

With certain lag we then identify an impact of the monetary policy shocks on inflation deviations from the inflation target. That does not mean, of course, that whenever e.g. a positive monetary policy shock may occur, observed inflation would necessarily with some lag appear below the

[1] Battini, Kuttner and Laxton (2005) have documented successes in decreasing inflation in numerous developing economies that introduced inflation targeting at the end of the 1990s or early after 2000.
[2] This condition gains even more on importance when a hypothesis cannot be excluded that monetary policy did actually something else than what it publicly committed itself to.

inflation target. In practice, inflation might as well hit precisely the target or even get above it, as a result of other shocks' impact. The virtue of the method we have applied is that even in such case we are able to estimate impacts of monetary policy shocks and document whether or not monetary policy was set consistently with the declared inflation target. Another advantage of the method consists in the fact that, in order to identify monetary policy shocks, it makes no difference based on what analyses the central bank was actually making decisions. The resulting identification of monetary policy shocks, while subject to specification of the used economic model, is independent of the analytical framework used within the central bank.

It definitely applies on the other hand that identification of monetary policy shocks in itself provides only information as to when the central bank set the nominal interest rates below or above the level consistent with the observed state of the economy and inflation target, without actually revealing why the central bank did so. Certain, however to quite a degree only *weak* conclusions on the reasons may be arrived to through the analysis of other shocks identified at the same time as the monetary policy shock, or, prior or after such a time. If, for example, we identify a strong monetary policy shock together with a counteracting effect of an exchange rate shock both effecting the observed interest rates, we may be able to judge of a slow response of monetary policy vis-à-vis the exchange rate shock. An isolated presence of a monetary policy shock may then actually represent a sign of incorrectly directed interest rates.[3]

Whatever the reason of occurrence of monetary policy shocks, their very existence (in particular if their realization went rather one way) could lead other economic subjects to perceiving the central bank as an institution targeting other inflation target in practice than the declared one. In such case, economic subjects may not perceive the central bank as an institution that makes mistakes when it tries to achieve its inflation target but as an institution that is presumably pursuing another target and that in fact does not make mistakes. Under such circumstances, the inflation target may be qualified as an unobserved variable and estimated along a similar method applied to other unobserved variables.

The rest of the paper is structured as follows: Section 2 contains a more detailed description of the used economic model and estimation method. Section 3 follows up with a description of the estimated results, i.e. an analysis of deviation of nominal interest rates and inflation from their respective long-term values in response to different shocks. Section 4 presents an estimate of the inflation target in the absence of monetary policy shocks and Section 5 summarises all results.

2. THE MODEL AND THE ESTIMATION METHOD

As indicated above, the basic principle of our method consists in identifying economic shocks (directly unobserved) using a structural model of the Czech economy and information contained in the observed variables, where the link between the observed and unobserved variables is represented by the economic model itself. Criteria for the model selection are then defined by the questions we attempt to answer. In our case, analysing the economy under the inflation targeting regime requires that the model includes endogenous monetary policy and fairly reflects its transmission mechanism. The point is that if the monetary policy were absent in the model, expectations of economic subject could not be accurately described (Lucas, 1976). The model should at the same time have a sufficiently rich supply (production) structure to enable its own

[3] Incorrect directing should be understood to also include leaving interest rate at its current level in a situation requiring their change.

calibration based on the observed data and to enable use of information contained within the GDP components.

2.1 Structure of the model

The economy is described using a dynamic general equilibrium model, which was initialy described in Beneš, Hlédik, Kumhof and Vávra (2005), while the version we use, including parametrisation and features, is discussed in detail by Andrle, Hlédik, Kameník and Vlček (2008). In this paper we therefore provide only a verbal description of the key features of the model. The model includes the sectors of households, intermediaries in the financial market, domestic producers of intermediate good, importers of intermediate good, producers of consumption final good, exporters and producers of capital good. Parts of the model are also the central bank and government.

Households consume the final good basket and accumulate capital, lend the capital and supply differentiated labour force to the domestic producers of intermediate good. Further, households directly trade in domestic bonds and, through the financial market intermediaries, also in foreign currency denominated bonds. Households own all firms and, accordingly to their investments, share in the firms' profits. In addition to the corporate profits, households are recipients of government transfer payments. Households wage contracts are rigid, i.e. households cannot re-optimise their wage contracts at each period. Those households that are not enabled to optimise their wage contracts then index their wages to the last observed increase of wages. Finally, households move within the competitive insurance market (Yaari, 1965) that ensures for heterogeneous wages to have no impact on distribution of wealth among the households. This enables to use the representative household concept. During accumulation of capital, i.e. during their investment activity, households face adjustment costs associated with required capital level (Kim, 2003).

Financial market intermediaries operate on the perfectly competitive financial market and their operations are expected to always cover two periods. During their first period, intermediaries obtain funds from households and invest them in the international financial market; in the second period, they close their positions and return invested funds to the households. There are always two intermediary groups in each of the periods, one of them in the first stage of the financial operation and the other one in the second stage. When investing intermediaries face certain transaction costs, which existence is necessary for achieving model stationarity (Schmidt-Grohé and Uribe, 2003). The transaction costs are one of the government revenues.

Domestic producers of intermediate goods hire capital and labour force from households and, while operating on the monopolistically competitive market, each of them produces one type of an intermediate good. For production they use identical technology that involves labour augmenting technological progress. Producers maximise their profit under constraints represented by used technologies, costs of production factors and the non-zero probability that they will be unable to optimise their product price at every period. Differentiated intermediate goods are then combined with no additional costs for a composite intermediate good that is sold to the sector of final consumer and export good producers and sector of government consumption good producers.

In addition to the sector of domestic intermediate good producers, there is also the sector of intermediate good importers included in the model. Each importer combines its imported intermediate good from various foreign goods, prices of which are derived from prices of those goods in respective currencies and the nominal exchange rate. Similarly to domestic intermediate good producers importers of intermediate good face the non-zero probability that they will be unable to optimise their product price at every period. Imported intermediate good is then sold to the sector of consumer, export and capital good producers.

Final consumption good producers also operate on the monopolistic market and use domestic and imported intermediate goods as production inputs. The proportion in which both types of intermediate good are used is determined by production technology with constant elasticity of substitution. Rigid nominal prices exist in this sector like in other sectors, i.e. producers are unable to optimise their price at each period.

Exporters, too, use both domestic and imported intermediate goods for production, while the proportion of the goods use is again determined by production technology with constant elasticity of substitution. Exporter prices are rigid, like in other sectors, in the foreign currency though. Exports from the local economy compete with exports from various other countries and share imports of the foreign economy. Foreign demand for domestic export goods then may be expressed as a certain share in foreign imports, while the proportion is determined by the relative price of export goods to the price of foreign goods. With respect to the export sector, several different technology trends are additionally adopted and are discussed in more detail in the next section.

Capital good producers use only imported intermediate goods for production. This specification is based on high import share on investment expenditures as well as on our effort to avoid quick overflow of an increased capital accumulation into production of the domestic value added. Likewise in other sectors, producers in this one are unable to optimise their prices every period.

The last production sector includes government consumption good producers. Similarly to the capital good sector, in this sector producers use only a single production input, specifically a domestic intermediate good. Once again, producers are unable to optimise their production price at each period.

The government and central bank represent another two economic subjects present in the model. With respect to the government's revenues side, taxes and transaction costs arising in the financial market and at accumulation of capital are expected to flow in, while on the expenditure side, the government makes transfer payments and purchases government consumption good. The government may accumulate the debt but must guarantee its intertemporal solvency. This is achieved by applying a fiscal rule that adjusts the flow of the government transfer payment in a way ensuring governmental intertemporal solvency. Government consumption is then coupled with household consumption. The central bank is expected to carry out credible monetary policy under the inflation targeting regime. In order to achieve its inflation target, the bank manipulates the nominal interest rate around its neutral value, taking into consideration the current value of the interest rate and responding to expected inflation deviations from the inflation target. Specifically, the central bank responds to deviations of the year-on-year consumer price index growth from the inflation target at a year horizon. Potential impacts of different specification of the monetary rule on the recorded results are discussed in Section 2.4.

2.2 Technology trends and long-term growth

It is important for our method to avoid any ad hoc de-trending of observed time series. Therefore, the model structure is extended for both nominal and technology trends so as to enable direct use of the observed nonstationary time series.

While the nominal trend is a single one and it is determined by targeted inflation, six different real technology trends have to be used for replication of the observed data. Among them, the most important include general labour augmenting technology that enters the production function in the domestic intermediate good producer sector; specific technology of the export sector that maintains competitiveness of exporters in foreign markets; and, specific technology of the investment sector that helps to explain an increase (decrease) in investment share in the gross domestic product.

In addition to the above mentioned real trends, the model employs also a specific trend in labour supply that enables to explain long-term changes in the participation rate; specific technology trend in government consumption good production that helps to explain changes in share of government consumption in the gross domestic product; and, specific technology trend describing changes in quality of export goods. The latter helps to explain observed increase in the share of domestic exports in foreign imports taking place despite no observed change in relative prices of domestic export to foreign prices.

Use of all of the above trends is driven both by economic logic and need to explain observed data of a converging economy. It holds that real variables do not grow necessarily at an identical growth rate, while nominal shares of components of the gross domestic product keep constant.[4] Trend growths of technologies, as well as shocks hitting those growths, are estimated as unobserved variables jointly with an estimate for all other structural shocks.

2.3 Calibrating and testing

Andrle, Hlédik, Kameník and Vlček (2008) discuss in detail the calibration methods and tests of the model based on the data sample for the period from the first quarter of 1996 to fourth quarter of 2007. The main idea followed in model calibration is the 'minimal econometric approach' as suggested by Geweke (1999) and the used methods involve analysis of impulse responses; forecast error variance decomposition; analysis of model properties in time and spectral domains (King and Watson, 1996); and, recursive forecast. Andrle, Hlédik, Kameník and Vlček (2008) report inter alia on the ability of the model to forecast inflation in a 2-year horizon.

2.4 Estimation method

The first step at identifying structural shocks is to solve the model for its reduced form (Blanchard and Kahn, 1980 or Uhlig, 1995), which involves substitution of forward looking (non-predetermined) variables with a linear combination of past shocks. However, given non-linear nature of the used model, its equations have to be log-linearised first.

A reduced-form of the model serves as a starting point for the estimation of structural shocks based on the method of Kalman filtration. The Kalman filter applies a reduced-form of the model extended for measurement equations that map observed variables to the unobserved. Together they represent the 'state description of model'. The form is as follows:

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

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

[4] Fore more detailed discussion, see Andrle, Hlédik, Kameník and Vlček (2008).

wherein x denotes the vector of unobserved state variables, y vector of observed (measurement) variables, ε is a random vector we call process noise, and ν is measurement noise. At that, we assume a Gaussian distribution of random vectors and of x state vector's initial state.

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

Table 1: Observed variables for structural shock estimates

CPI (index)	Foreign 3M interest rates (EURIBOR)
Regulated prices (index)	Nominal exchange rate (CZK/EUR)
Net inflation (CPI adjusted for regulated prices, index)	Nominal wage (average wage in business sector)
Consumption deflator (index)	Real consumption (index)
Investment deflator (index)	Real investment (index)
Export deflator (index)	Real exports (level)
Import deflator (index)	Real imports (level)
Government consumption deflator (index)	Real government consumption (level)
Foreign prices (PPI, euro area, index)	Foreign demand (real imports of euro area, level)
3M interest rates (PRIBOR)	

The first step of the algorithm under the Kalman filtration is the prediction step. During the step, equation (2) is used to estimate the predictive probability density of states at time t based on the previous conditional probability density at time $t-1$. This probability density is however inexistent in the first period of the data sample and is therefore substituted with a random vector with a mean value and the unconditional variance of state variables as described by the equation (2). Due to the presence of trends within the model and resultanting non-stationarity of certain variables, the unconditional variance does not have a finite value and that is why a diffuse Kalman filter is applied (De Jong, 1991).

The filtration step follows after the prediction step, representing an update of the predictive probability density based on information contained in the observed data. The measurement equation (1) is used for that purpose. Additional information drawn from the observed data enables a refined estimate of state variables, also including estimate of shocks. In addition to the above Kalman filter steps, we use also a smoothing step of the filter which, as apposed to the prediction and filtration steps, uses complete information from the observed data (Harvey, 1989).

Application of the Kalman filter results in identification of unobserved state variables, i.e. including structural shocks. In the next stage the estimated realisations of different shocks are used for historical simulations of the model, with help of which we quantify exact impacts of different shocks on nominal interest rate and inflation. At historical simulation, we therefore simulate impact of each particular estimated realization of shocks (such as the exchange rate shock, shock in regulated prices etc.) on the deviation of nominal interest rates and inflation from their long-term values. While different shocks naturally have different impact directions and strength in particular periods of the data sample, we obtain actually observed realizations of nominal interest rates and inflation by summing up impacts of all shocks.

Hence, a solved structural model with endogenous monetary policy is used to identify structural shocks including monetary policy shocks. Using a particular type of the central bank reaction function may raise doubts as to the robustness of our results with respect to the form and calibration of the central bank's reaction function. In reality, there is no such issue. If we assume that given the structural form of the model we are able to identify absolutely correctly all structural shocks except for the monetary policy shock, then, irrespective of any concrete form of the monetary policy rule, it is the monetary policy shock remaining as the only one to replicate observed data. That is why this shock is determined unambiguously, despite a concrete form of the monetary policy rule.

3. BASIC DECOMPOSITION OF MONETARY POLICY

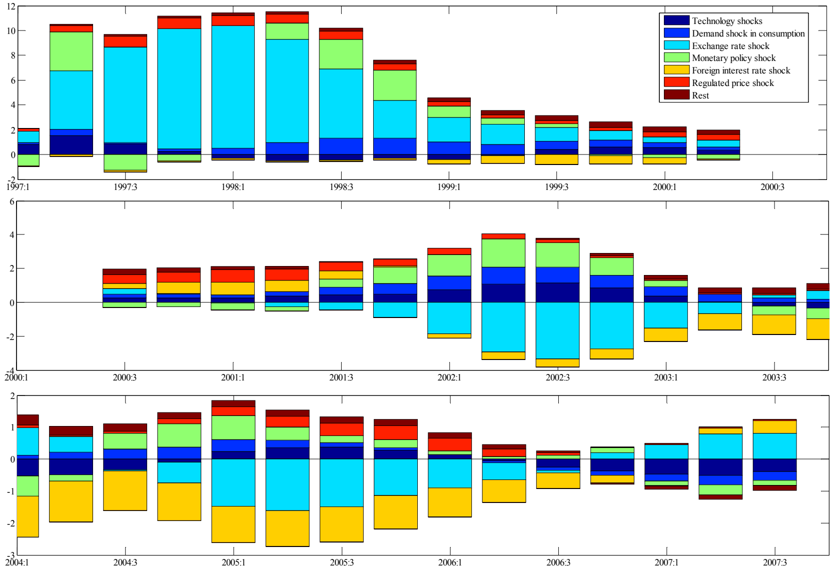
This section provides a detailed description of the historical decomposition of monetary policy, wherein the observed realizations of nominal interest rates and inflation are analysed by impact of different economic shocks. More precisely, we do not analyze effects of shocks on the nominal interest rate and inflation levels but effects economic shocks have on the deviation of nominal interest rate and inflation from their long-term levels. This is what follows from the key assumption of our analysis - that only economic shocks cause deviation of any variable from its respective long-term level. Such long-term level is represented by the inflation target in case of inflation and by the sum of the equilibrium real interest rate and inflation expectations (or, inflation target in the long run) in case of nominal interest rates.

Figure 1 shows the decomposition of nominal interest rates to the contribution of estimated shocks in the period from the beginning of 1997 to third quarter of 2007.[5] Table 2, in order to facilitate orientation, then sets out brief interpretations of those shocks, while Table 3 contains exact numbers for monetary policy shocks. It follows from Figure 1 that the exchange rate shocks were the key determinant for the nominal interest rate setting (its deviation from the long-term level). The other determinants are shocks in foreign interest rates and monetary policy shocks. The latter are crucial for the purpose of our analysis. The monetary policy shock appears in the figure whenever nominal interest rate setting was not fully consistent with the observed state of the economy and inflation target. It also applies that whenever such shock is positive, nominal interest rates were set higher than ideally consistent with the observed state of the economy and inflation target, and vice versa.

The first period following introduction of inflation targeting for which we identify a sequence of positive monetary policy shocks starts as from the second quarter of 1998 and ends with third quarter of 1999. The highest contribution of the monetary policy shock is estimated for the third and fourth quarter of 1998. As a result, we may note that especially in the course of the second half of 1998, monetary policy was set more restrictive than would correspond to the observed state of the economy and inflation target. At the same time, behaviours of the other shocks seem to suggest that the monetary policy shock occurs due to an insufficiently quick response by the central bank to fading pro-inflationary effect of the exchange rate shock. We may but speculate on the reasons for such slow response.

[5] In order to obtain a more robust estimate, we use the data since 1996.

Figure 1: Decomposition of interest rates (deviation from the long-term level in pp)



Source: Own calculation.

Table 2: Basic interpretation of shocks

Technology shocks	Sum of shocks identified in all technology trends.
Demand shock in consumption	Shock identified in household consumption.
Exchange rate shock	Shock identified in the exchange rate equation (the uncovered interest rate parity)
Monetary policy shock	Shock identified in the monetary policy rule.
Foreign interest rate shock	Shock identified in foreign interest rates.
Regulated price shock	Shock identified in the regulated price development.
Rest	Sum of all other identified shocks (such as foreign demand, investments and government consumption).

Table 3: Impact of monetary policy shocks on the deviation of nominal interest rate from its long-term level (in pp)

1997Q1	-0.91	2000Q4	-0.25	2004Q3	0.49
1997Q2	3.13	2001Q1	-0.38	2004Q4	0.74
1997Q3	-1.24	2001Q2	-0.26	2005Q1	0.76
1997Q4	-0.49	2001Q3	0.48	2005Q2	0.40
1998Q1	-0.01	2001Q4	0.95	2005Q3	0.21
1998Q2	1.35	2002Q1	1.26	2005Q4	0.25
1998Q3	2.38	2002Q2	1.68	2006Q1	0.12
1998Q4	2.43	2002Q3	1.44	2006Q2	0.07
1999Q1	0.92	2002Q4	1.02	2006Q3	0.12
1999Q2	0.51	2003Q1	0.36	2006Q4	0.15
1999Q3	0.30	2003Q2	-0.02	2007Q1	-0.13
1999Q4	-0.09	2003Q3	-0.52	2007Q2	-0.31
2000Q1	-0.27	2003Q4	-0.61	2007Q3	-0.17
2000Q2	-0.34	2004Q1	-0.63		
2000Q3	-0.30	2004Q2	-0.19		

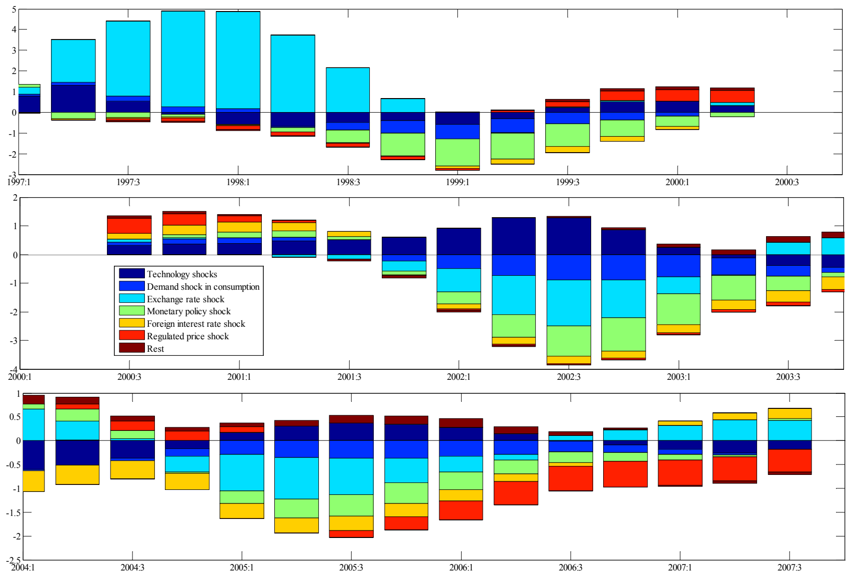
Source: Own calculation.

An explanation may be suggested by considering the monetary policy risk aversion at the inflation targeting regime launch. At that time, monetary policymakers dealt with numerous uncertainties represented by the estimates of equilibrium trends, power of the transmission channel, as well as an inefficient banking sector and underdeveloped financial market. They were probably also aware that had declared disinflation been unsuccessful, any subsequent attempt would have been much more costly. Therefore, the decision to decrease the interest rate more slowly than would be otherwise optimal might have been motivated by the risk aversion that led the monetary policymakers to transferring into the present time a portion of the expected costs of future disinflation attempts.

Figure 2 and Table 4 consistently describe monetary policy as a significant and comparatively long-term factor of a negative deviation of inflation from the inflation target. The above discussed monetary policy shock itself pushes inflation below the inflation target during the period from the second quarter of 1998 to second quarter of 2000, i.e. over the first two years of the new monetary policy regime.

During the second half of 1999 and then until the second half of 2001, we identify no marked monetary policy shocks and even if so, negative ones prevail. We may therefore note that, during that period, nominal interest rates were set consistently to the inflation targets and to the observed economic development.

Figure 2: Decomposition of inflation (deviation from the long-term level in pp)



Source: Own calculation.

However, as may be seen from Figure 1, the situation begins to change in the second half of 2001, during which a marked exchange rate shock hit the economy, followed in addition by another shock of falling foreign interest rates. A positive monetary policy shock arises concurrently to a negative exchange rate shock. This may indicate that the reason behind the monetary policy shock might have been an insufficiently quick response by the central bank. The size of the monetary policy shock rises gradually, while the central bank succeeds in damping the tendency as late as in the third quarter of 2002 when the absolute amount of the monetary policy shock gets decreased, despite the culminating exchange rate shock.[6] The described monetary policy shock then adds to the pressure on inflation decrease below the inflation target, as may be seen from the inflation decomposition in Figure 2 and Table 4. The shock itself ebbs away in the second half of 2003, however its impact on inflation is present until the end of that year.

The period from the third quarter of 2003 to second quarter of 2004 is the time of negative monetary policy shocks. Nominal interest rates were kept lower during the period than would have been consistent with the observed state of the economy and inflation target. We identify the most marked negative shock in the first quarter of 2004, during concurrent effects of a positive exchange rate shock.[7] In the third quarter of 2004, a positive monetary policy shock however appears once again and survives, albeit very modestly, until the first quarter of 2006. Identically to the previous

[6] The interest rates were decreased by 0.75 pp in July 2002. During the first half of 2002, CNB was additionally making efforts to stop the exchange rate appreciation by interventions in the foreign exchange market.

[7] In the first quarter of 2004, a temporary depreciation of the koruna peaked, recording the average 32.90 CZK/EUR in that quarter.

example, the positive monetary policy shock is accompanied by a negative exchange rate shock. As opposed to the previous period, exchange rate shocks rather tend to follow after a monetary policy shock. As may be seen in Figure 2, while a positive monetary policy shock occurs in the third quarter of 2004, a negative exchange rate shock follows only in the fourth and subsequent quarters. That might suggest that the central bank itself could possibly partly contribute to the exchange rate shock occurrence as the foreign interest rate caused a strong pressure on the low level of domestic interest rates during that period.[8] It is therefore possible that the observed state of the economy was not entirely accurately assessed in the made analyses or monetary policy decision, or, that monetary policy setting was adjusted at the point of time that was already unsuitable for that.

Table 4: Impact of monetary policy shocks on the deviation of inflation from its long-term level (in pp)

1997Q1	0.14	2000Q4	0.12	2004Q3	0.17
1997Q2	-0.31	2001Q1	0.20	2004Q4	-0.03
1997Q3	-0.24	2001Q2	0.23	2005Q1	-0.26
1997Q4	-0.12	2001Q3	0.11	2005Q2	-0.40
1998Q1	-0.04	2001Q4	-0.12	2005Q3	-0.45
1998Q2	-0.20	2002Q1	-0.42	2005Q4	-0.43
1998Q3	-0.61	2002Q2	-0.77	2006Q1	-0.37
1998Q4	-1.09	2002Q3	-1.04	2006Q2	-0.29
1999Q1	-1.29	2002Q4	-1.16	2006Q3	-0.23
1999Q2	-1.27	2003Q1	-1.08	2006Q4	-0.19
1999Q3	-1.08	2003Q2	-0.85	2007Q1	-0.12
1999Q4	-0.79	2003Q3	-0.51	2007Q2	-0.03
2000Q1	-0.47	2003Q4	-0.17	2007Q3	0.04
2000Q2	-0.20	2004Q1	0.11		
2000Q3	0.00	2004Q2	0.25		

Source: Own calculation.

Looking more closely at the recorded results, one cannot leave unnoticed the fact that the impact of monetary policy shocks on inflation is more persistent than the very existence of the shocks. Out of 39 observed periods (counted from the first quarter of 1998), monetary policy acted more anti-inflationary during 30 periods (and, to a comparatively limited extent at three out of these observations, i.e. less than 0.1 pp) that would have been consistent with the observed state of the economy and inflation target.

Whatever the reasons for the behaviour, an argument may be certainly made that the economic subjects, based on their own observations, might gradually begin to perceive the central bank as asymmetric in terms of meeting the published inflation target. In such case, economic subjects, instead of feeling about the central bank as an institution that, while making mistakes, nevertheless keeps on following its declared inflation target, would perceive it as an institution that in fact pursues another target without actually making many mistakes. In the next section, we therefore discuss the inflation target estimate as an unobserved (state) variable under the circumstances where the central bank monitors the state of the economy and avoids mistakes at monetary policy setting, while perceived as such by other economic subjects.

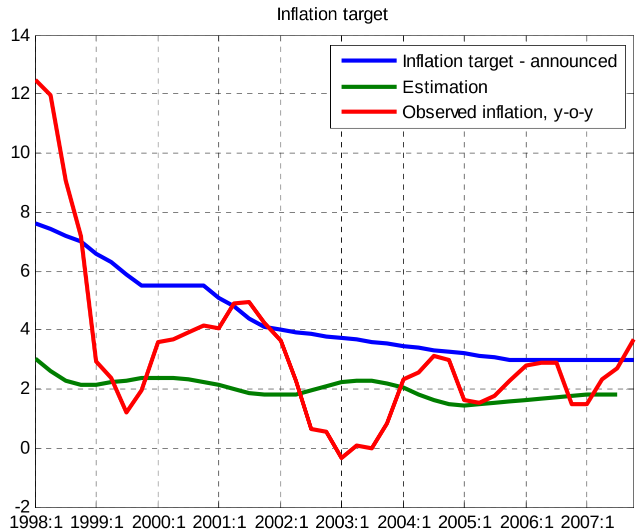
[8] In August 2004, the interest rate was increased by 0.25 pp. The decision to increase it followed the July forecast that was consistent with an rising trajectory of interest rates (See the Inflation Report of July 2004).

4. INFLATION TARGET AS AN UNOBSERVED VARIABLE

Prior to entering the discussion of the estimate, we should however repeat that an inflation target estimated using the above described methodology represents a target perceived by the economic subjects as the central bank's real target, while it is at the same time also the target truly pursued by the central bank. Obviously, an ideal approach would be to estimate an implicit inflation target understood by the economic subjects as the one followed by the central bank, while the bank would in fact follow the formally declared target, while mistakes (monetary policy shocks) would be allowed. The present economic literature on heterogeneous expectations and information, however, has been making its first strides and is so far unable to provide a sufficiently robust toolkit for practical application with real data.

Figure 3 presents the inflation target estimate together with the declared target and inflation. The estimate robustness is at the same time derived from the stability of estimates for other unobserved variables (technology trends, in particular), compared with the situation where the target is observed and monetary policy mistakes are allowed. In other words, the robustness and reliability of the estimate is derived from an identical estimate of the business cycle.

Figure 3: Inflation, declared inflation target and its estimate (in %)



Source: Own calculation.

It may be seen at once that the estimated target moves below the declared target level throughout the period under review, while the absolute difference between the two is decreasing over time. The beginning of the estimate may be naturally affected by quite quick observed disinflation during 1998 and 1999 as well as by our approximation of the inflation target, as the target was in fact

declared for net inflation, for the respective year-ends and as a corridor in addition to that.[9] Since 2002, when an explicit continuous trajectory of the inflation target came into existence, the estimated target moves within the band of 2 and 3%. The estimated inflation target may be interpreted as an explanation for the central bank behaviour at the same estimation of the business like in previous case and in the absence of mistakes in monetary policy implementation.

5. CONCLUSIONS

The inflation targeting regime was effectively introduced by the Czech National Bank since the beginning of 1998 and, already during the autumn of that year, observed inflation fell markedly below the inflation target published for that year-end. Inflation targets defined for respective year-ends were repetitively undershoot also in 1999 and 2000. Holub and Hurník (2008) further report that from January 2002, when the continuous target was introduced, till the end of 2007, inflation moved below the target for some 90% per cent of the period and for 51% of the time even below its lower tolerance interval.

The above outline history of fulfilling the inflation targets necessarily evokes the question of reasons for their undershooting, including obvious emphasis on the role of monetary policy itself. This paper has attempted to provide an answer to the question from the perspective of a dynamic general equilibrium model, designed and calibrated to fit the Czech economy data.

The strong conclusion of our analysis consists in the estimation of structural economic shocks that indicates more restrictive monetary policy during three periods since the beginning of 1998 than would have been consistent with the observed state of the economy and declared inflation target. The first period lasted from the second quarter of 1998 to first quarter of 1999, the second period from the third quarter of 2001 to the second quarter of 2003 and the third period from the third quarter of 2004 to the end of 2005. For one period, we identify more relaxed monetary policy, specifically from the third quarter of 2003 to the second quarter of 2004.

The weak conclusion is represented by our view that, in the first instance, the most probable reason was a slow response to an already fading previous pro-inflationary shock, and, in the second instance, a slow response to an exchange rate appreciation shock in progress, and, in the third instance, erroneous directing of interest rates during a period that was no longer justifying such a step.

Given comparatively frequent observations of the positive monetary policy shocks in the past, it is conceivable that the inflation target as perceived by the economic subjects deviated from the inflation target declared by the central bank. While the latter hypothesis cannot be tested following an entirely correct approach, our experiment with an unobserved inflation target may provide certain degree of approximation. The inflation target oscillating between 2 and 3% in the period since 2002 is conveniently suitable for explaining the central bank behaviour though such an optic.

[9] Detailed description of the history of the CNB's inflation targets may be found in Kotlán and Navrátil (2003) or, more recently, in Holub and Hurník (2008). The approximation of the inflation target in headline inflation prior to 2002 is based on the targets published for net inflation. To the midpoints of these targets (the targets were declared as a corridor), 1 pp is added as an estimated average contribution made by regulated prices to the headline inflation, while the targets are interpolated to individual quarters using a linear trend (the targets were declared for the year-ends).

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