CHAPTER 2

BASIC CHARACTERISTICS OF INFLATION TARGETING IN THE CZECH REPUBLIC

JURAJ ANTAL
MICHAL HLAVÁČEK
TOMÁŠ HOLUB

1. INTRODUCTION

This paper deals with the description of basic characteristics of inflation targeting in the Czech Republic. The first part of the paper starts by briefly indicating some general macro-economic conditions of inflation targeting in the Czech Republic, including the identification of the main shocks, which affected them. This basic description further serves (Section 3) the discussion of the extent of (non-)fulfilment of the target, based on a comparison of the actual course of inflation compared to the targets in various phases of inflation targeting in the Czech Republic in the years 1998 to 2007. The fulfilment of the target is evaluated here using several simple approaches, such as the average deviation from the target, the Root Mean Square Error (RMSE), the ratio of time with inflation under the target or the application of the t-tests of deviation of inflation from the centre of the target and the evaluation of the target fulfillment in view of the hypothetical loss function of the central bank.

The second part of the paper (Section 4) then provides a comparison of the extent of non-fulfilment of the inflation target in the Czech Republic to the experience of several foreign countries, which also apply inflation targeting. This paper does not deal with an analysis of sources of prediction errors or any formal analysis of the success-rate of inflation targeting in the individual countries, or comparisons to any countries, which do not perform inflation targeting (see e.g., Ball, Sheridan, 2003). Our goal is to provide a basic description of the course of the deviations of inflation from target in some selected countries, making use of some basic descriptive statistics and graphic illustrations. This approach may inspire a more formal analysis of shocks, which affected inflation in the individual countries. If we discover any common development of the deviations of the inflation from the target among individual countries, this may serve as a signal of the existence of a potential common source of such deviations. That may provide the information on whether the extent of the target non-fulfilment in the Czech Republic compares with the other countries, and/or it could help us identify periods of major global shocks, which affected all countries implementing inflation targeting.

The conclusion of the paper can be summarized as follows: challenges related to the fulfilment of the goals of the monetary policy concentrated within two periods of time (1998-99 and 2002-03), which were marked with episodes of exchange rate appreciations, something that the monetary policy could not (or did not want to) respond to in a sufficiently quick and resolute manner. The exchange rate appreciation episodes were very strong and their consequences were fairly persistent so the occurrence of two such episodes in less than ten years could have caused a deviation in the direction of target undershooting (at the same time, however, it is hard to explain why no target overshooting took place during the period of exchange rate depreciation and pro-inflationary shocks). Moreover, the periods characterised by the strengthening of the exchange rate were combined with some other anti-inflationary factors, some of which were of a global nature. This has been documented also by the fact that periods of target undershooting in the Czech Republic correspond to periods of low inflation in the sample of other economies targeting inflation.

A comparison of the inflation target fulfilment in various phases of inflation targeting shows a changing success rate in the fulfilment of the target in time. While deviations of inflation from the targets were very high in international comparison in the early phase of inflation targeting, the Czech National Bank has lately come closer to the characteristics of relatively more successful inflation targeters. This may result from a process of "learning", whereby the Czech National Bank has been gradually applying more advanced approaches of the execution of its monetary policy. At

the same time, this may be the outcome of a generally more stable macro-economic situation in the Czech Republic as compared with the initial years of inflation targeting. The Czech National Bank does not stand out significantly in the group of the central banks in the inflation-targeting emerging market economies as far as the frequency and extent of missing the target tolerance band is concerned. However, it has a specific (although not exceptional) position due to having undershot the target on average, with the empiric distribution of the inflation deviations from the target fairly significantly asymmetrical. Our simple analysis shows that the periods of the most extensive target undershooting in the Czech Republic in the years 1998 to 1999 and 2002 to 2003 correspond fairly well also to the periods characterised by the most frequent occurrence of negative deviations of inflation from target among the group of the monitored economies. It seems, therefore, that the Czech Republic, at least to a certain extent, suffered from global anti-inflation shocks within these periods.

2. MACRO-ECONOMIC DEVELOPMENT AND TARGET FULFILMENT OVER THE PAST 10 YEARS

Prior to the evaluation of the inflation targeting record in the Czech Republic, it is useful to briefly mention in the introduction the general economic context of inflation targeting in the Czech Republic (see Table 1). The Czech National Bank announced its first inflation target in December 1997. The beginning of inflation targeting was marked with the aftermath of the financial turbulence occurring in the Spring of 1997 and by the related challenging overall macro-economic situation (high inflation as well as inflationary expectations, despite high interest rates, a drop in the real GDP, depreciation of the exchange rate, high deficits of the trade balance).[1] A certain "backward looking nature" or "cautiousness" of the monetary policy in that period, therefore, could mean that any improvement of the situation as compared with the very turbulence (in 1998 appreciating exchange rate of the crown and improved trade balance, renewal of foreign direct investment inflows, a drop in the interest rates as well as inflation, etc.) could result in a material non-fulfilment of the target in the years 1998 and 1999.

A partial improvement of the economic growth in the years 1999 and 2000, however, was followed by its repeated slowing down, which was connected, among other things, also with an excessive appreciation of the crown at the end of 2001 and in 2002, combined with low international demand. This appreciation was caused, among other things, by a fairly strong inflow of foreign direct investment and market expectations about future major privatisations. Although the response by the Czech National Bank to the appreciation was fairly strong,[2] its scope was so large that a further significant undershooting of the target could not be prevented.

However, foreign direct investments made in the period of 2003 to 2007 assisted an acceleration of the economic growth, a drop in unemployment as well as an improved trade balance. The trade balance has recorded surpluses ever since 2005, despote the continued appreciation of the crown

---

[1] For a more detailed discussion of the causes and consequences of the financial turbulence, see e.g. Šmídková, et al. (1999) or Dědek (2000).
[2] The CNB two-week REPO rate dropped from 5.25%, which applied at the beginning of November 2001, down to 2% as of 1 August 2003 (that is, below the level prevailing in the eurozone). The Czech National Bank performed fairly extensive intervention in the foreign exchange market in 2002 (for a description and an analysis of the success rate of foreign exchange interventions, see e.g. Geršl and Holub (2006)), and the exchange rate appreciation was addressed also by some less standard approaches of sterilisation of the capital inflow from the privatisation of the State property (see e.g., CNB (2002)).

exchange rate. The improvement of the overall macro-economic situation over the past five years has also been to a large extent caused by the positive effects of the accession of the Czech Republic to the European Union at the beginning of 2004. An example of such positive effects is represented by improved institutional environment in the Czech Republic in connection with the accession, better access to the EU markets, and further strengthening of the inflow of the capital from the EU.

**Table 1: Development of basic macro-economic variables in the Czech Republic**

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2005	2007
Real GDP growth rate		-0.7	-0.8	1.3	3.6	2.5	1.9	3.6	4.5	6.4	6.4	6.5
Year-on-year CPI inflation		10	6.8	2.5	4	4.1	0.6	1	2.8	2.2	1.7	5.4
Interest rates (3M PRIBOR)		17.6	9.5	5.5	5.4	4.6	2.6	2.1	2.6	2.2	2.6	4.1
Year-on-year exchange rate change CZK/USD[1]		26.7	-13.8	20.5	5.1	-4.1	-16.9	-14.9	-12.8	9.9	-15.1	-13.4
Year-on-year exchange rate change CZK/EUR[1] [2]		9.9	-7.6	3.4	-2.9	-8.9	-1.2	2.6	-6.0	-4.8	-5.2	-3.2
Unemployment (Labour Force Survey)		5.4	7.3	9.0	8.3	7.8	7.3	8.1	8.2	7.8	6.5	4.8
Balance of payments (in % of GDP)	Current account	-6.2	-2.0	-2.4	-4.8	-5.3	-5.5	-6.2	-5.2	-1.6	-3.1	-2.5
	of which: Trade balance	-8.6	-4.2	-3.2	-5.5	-5.0	-2.9	-2.7	-0.5	2.0	2.0	3.3
	Balance of services	3.1	3.1	2.0	2.5	2.5	0.9	0.5	0.6	1.2	1.3	1.6
	Incomes balance	-1.4	-1.8	-2.2	-2.4	-3.6	-4.7	-4.7	-5.6	-5.2	-6.2	-7.1
	Foreign Direct Investment	2.2	5.8	10.4	8.7	8.9	11.0	2.1	3.6	9.4	3.2	4.4

Source: Czech Statistical Office, Czech National Bank. Notes: 1) A positive value represents year-on-year depreciation, a negative value represents year-on-year appreciation; 2) The CZK/DEM exchange rate change for the years 1997 to 1999.

3. EXTENT OF TARGET NON-FULFILMENT AND ITS DEVELOPMENT IN TIME

Figure 1 shows the development of inflation as compared with the CNB targets. It shows that the Czech National Bank entered the inflation targeting regime at a time of relatively high inflation,[3] and one of the main intentions behind its introduction was to achieve disinflation and reduce inflationary expectations (see CNB, 1998). In this respect and during this period, the monetary policy of the Czech National Bank can be assessed as relatively successful since the high inflation faded quickly. Subsequently, the Czech National Bank was – for the entire inflation targeting period –mostly undershooting the target, while its overshooting occurred only in exceptional cases. Target undershooting was most pronounced at the end of the years 1998 and 1999, and in 2003. Out of the four net inflation targets, (the first) two were substantially undershot, one was moderately undershot, and one (the last one) was fulfilled. So far, the headline inflation targets have been undershot in a slightly more than one half of the cases (37 cases in 72 months), while inflation fluctuated under the middle of the target band (65 cases in 72 months) for most of the time.

---

[3] The year-on-year inflation in the Czech Republic in the first quarter of 1998 reached the historically highest rate since 1994 (in 1993, inflation was still higher due to the introduction of the value added tax). An increase of the year-on-year inflation in January 1998 was mainly contributed to by the administrative factors (increased VAT on energy from 5% to 22%, higher excise taxes, price deregulation), the previous increase of inflation in the second half of 1997 was related in particular to the depreciation of the exchange rate during the financial turbulence.

Figure 1: Inflation – targets vs. reality
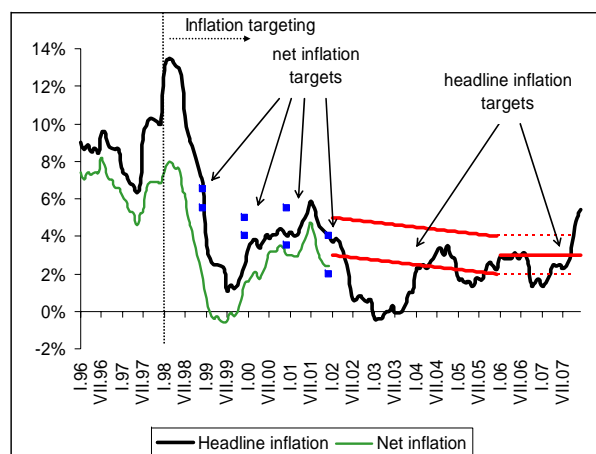
Source: Czech Statistical Office and CNB estimates.

Table 2 shows the basic descriptive statistics of inflation target fulfilment, including their comparison for the main periods of inflation targeting. The table shows that inflation was on average roughly 1.7 percentage points below the target for the entire inflation targeting period. At the same time, the extent of undershooting was more significant in the net inflation targeting period (2.5 percentage points) than in the headline inflation targeting period (1.3 percentage points). The "Root Mean Square Error" (RMSE) statistics, which reflects the average target undershooting as well as inflation volatility around the target, reached 2.5 % for the entire period (3.3 % for the net inflation period, and 2.0 % for the headline inflation period).[4] The average deviation of inflation from the target for the entire inflation targeting period has been statistically significant at the 1 percent level. This standard test, however, is based on the assumption of independent random distribution of the individual observations, which does not hold in practice, as inflation deviations from the target have been significantly auto-correlated. Therefore, an AR(2) process[5] for the time series of deviations from the target was estimated as an alternative test, and statistical significance of the (negative) constant in the process was tested. The constant was identified as statistically significant at a 5 percent probability level. This evidence counters the hypothesis of shocks skewed in the anti-inflationary direction, although it needs to be pointed out at the same time that this is a very mechanical statistical test, which does not analyse any causal links.

Table 2 also indicates gradual improvement of the target fulfilment in various phases of inflation targeting in the Czech Republic. In the initial phase, the Czech National Bank introduced targeting of net inflation, which did not contain any impact of the changes of indirect taxes and

---

[4] See also Holub and Hurník (2008).

[5] The AR(1) process was not sufficient to remove auto-correlation of residuals. This is because the inflation deviation from the target, in the event of major shocks, tends to increase for some initial time before its turn and gradual disappearance. This dynamics is better described by an AR(2) process, as also confirmed by the statistical significance of the AR(2) term at the 1% significance level.

---

deregulations.[6] The subsequent phase may be described as a transition to headline inflation targeting motivated, among other things, by better comprehensibility of such inflation rate for the public (see CNB (2001)). In the last phase, which can be formally connected to the introduction of a more sophisticated model apparatus applied by the Czech National Bank since 2002,[7] the practice of inflation targeting in the Czech Republic came close to the "best practice" in those countries where inflation targeting has had a years-long tradition. Beside the above-mentioned introduction of a higher-quality core prognostic apparatus, this step primarily involved increased quality of supporting statistical and econometric analyses, improved communication of the Czech National Bank as well as the entire decision-making process regarding the monetary policy decision-making.

Table 2: Inflation deviation from target – basic statistics

	Period	Number of observations	Average deviation	Standard error	Root Mean Square Error	Ratio of cases in %			
						Under the middle of target[3]	Under the band	In the band	Above the band
Inflation targeting – total[1]	1/99-12/07	109	-1.74	1.80	2.51	90.83	59.63	37.61	2.75
Net inflation [1]	12/98-12/01	37	-2.53	2.14	3.32	91.89	75.68	21.62	2.70
Headline inflation	1/02-12/07	72	-1.34	1.44	1.96	90.28	51.39	45.83	2.78
Prior to introduction of QPM[2]	1/02-7/03	19	-2.71	1.36	3.04	100.00	78.95	21.05	0.00
After introduction of QPM[2]	8/03-12/07	53	-0.84	1.10	1.39	86.79	41.51	54.72	3.77
Monetary-policy relevant inflation	1/02-12/07	72	-1.61	1.24	2.03	97.22	66.67	31.94	1.39

Notes: 1) The "December" net inflation targets had to be linearly extrapolated into the separate months, subject to equal reduction of the target in the course of each year;
2) The QPM model was introduced in April 2002; given the monetary policy delays estimated at 4-6 quarters, we deemed the "QPM period" to commence in August 2003 (that is, with a delay of 5 quarters);
3) The ratio of cases "above the middle of the target" complements the ratio of the cases under the middle of the target up to 100%.

Following a change in the targeting from net inflation to headline inflation, the average target undershooting increased (the deviation from the target grew from -2.5 % to -2.7 %) as well as, to some extent, the frequency of target undershooting (an increase from 75.7 % cases under the target band to 79 % cases). This can to a certain extent be explained by a larger number of headline inflation items outside the reach of the monetary policy as against net inflation (regulated prices, indirect taxes), which – immediately following the change to headline inflation targeting – surprised the Czech National Bank in the downward direction due to the declining global energy prices. However, the extent of target undershooting relatively significantly declined during the last, i.e. advanced phase of inflation targeting.

It is interesting – but not surprising – to note that if we apply the so-called monetary-policy relevant inflation[8] in measuring inflation deviations from the target, then the average target undershooting is higher than its evaluation with help of headline inflation (the average deviation of -1.6 % as against -1.3 % for headline inflation). This situation ensues from the fact that tax changes executed in the

---

[6] For definition of the net inflation target, see CNB (1999). The recently published "Transcripts of the Bank Board Meetings" (CNB (2008)) represent a unique opportunity of how to get involved in the decision-making of the Czech National Bank regarding the setting-up of the monetary policy in that period.

[7] QPM (Quarterly Prediction Model) introduced in May 2002 represents a so-called "unconditional model" comprising also an estimate of the future development of interest rates (for description of the original model, see CNB (2003), for its partial changes, see CNB (1998-2007)). The previous models were so-called "conditional models", which presumed a constant level of interest rates.

[8] Monetary-policy relevent inflation represents inflation to which the monetary policy reacts ex ante. It is defined as headline inflation adjusted for the primary effects of changes to indirect taxes.

past resulted in the overwhelming majority of cases in increased inflation, and thus brought headline inflation closer to the target. In the following text, however, we do not mention monetary-policy relevant inflation due to two reasons. Firstly, it would disturb international comparability of the results for the Czech Republic because all international comparative studies are based on comparisons of officially targeted price indices with the declared targets, and they do not consider any potential *ex ante* escape clauses from target fulfilment. Secondly, the application of escape clauses was changing in the course of inflation targeting in the Czech Republic and it would be difficult to approach it in a consistent manner.[9]

Figure 2: Target fulfilment indicators in the individual years (average values of the indicators in the individual months of a given year)
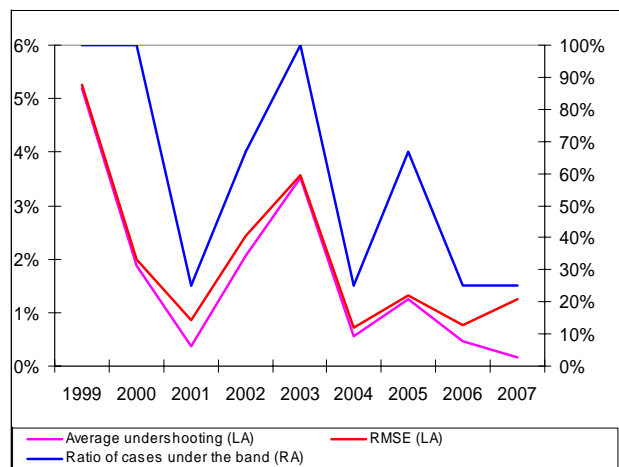

The fact that the extent of target undershooting was changing in the course of time is obvious also from the comparison of the development of the target fulfilment indicators in the individual years (see Figure 2). This development shows a fairly significant fluctuation in the success-rate of fulfilment of inflation target. In the years 1999, 2002, and 2003, a fairly significant worsening occurred in hitting the target, while on the other hand, inflation came closer to the target in the years 2001 and 2004 to 2007.[10] Despite the rather significant volatility of the target fulfilment indicators, the figure also indicates the above-described trend of gradual improvement of target fulfilment in time.

---

[9] E.g., in 2002-2005, there was an option of applying an *ex ante* escape clause to the contribution of regulated prices to inflation outside the interval of 1-1.5 percentage points. If such an escape clause was taken into consideration, it would reduce the extent of target undershooting in the years 2002-2003, which is something we do not opt for in this analysis.

[10] The strong correlation between the RMSE indicator and the average target undershooting in a given year results from the fact that the Czech National Bank was overshooting its inflation target only in exceptional cases, and to a very minor extent. Moderately differing development of these indicators in 2007 results from the overshooting of inflation at the end of 2007, which reduced the average inflation undershooting but had a positive impact on the RMSE indicator.

Figure 3a: Loss function components[12]
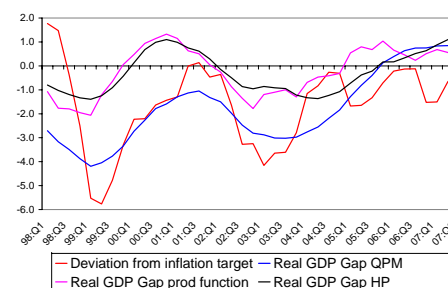
Figure 3b: Loss function values (3/4 inflation, 1/4 output gap[12])
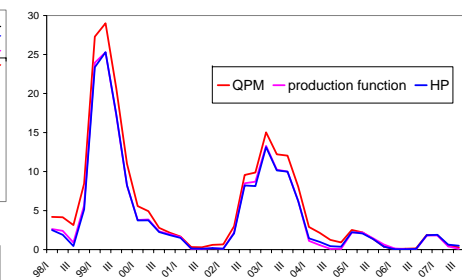
Source: CNB, own calculation.

The time dimension of target undershooting will also come out if we interpret the periods of the largest missing of the target with help of values of a hypothetical central bank loss function (see Kotlán and Navrátil (2003)). In line with the standard assumptions contained in economic literature concerning central bank preferences under the flexible inflation targeting regime, the applied loss function weighs the square of inflation deviations from the target and the square of the output gap.[11] Components of the loss function are shown in Figure 3a, which shows a clear relationship between the extent of inflation targets undershooting and the various estimates of the output gap;[12] any significant undershooting of the target was typically linked to the widening of a negative output gap, while coming closer to the target was accompanied either by closing the negative output gap or its opening into positive values. Calculations of the values of the loss function for $\alpha = 3/4$ are shown in Figure 3b. They confirm the previous conclusion that the most serious problems regarding the fulfilment of inflation targets concentrated into the years 1998-1999 and 2002-2003. Those periods saw inflation target undershooting as well as negative output gaps at the same time, pursuant to all and any approaches we applied. On the other hand, in the years 2000-2001 and 2004-2007, inflation returned closer to the inflation targets following the previous shocks, and the economy stabilised close to its potential. The figure shows that if the output gap from the QPM model determined with help of the Kalman filter approach is applied, the value of the loss function is the highest. This

---

[11] The loss function was specified as follows: $L_t = \alpha \cdot (\pi_t - \pi_t^{TAR})^2 + (1-\alpha) \cdot (y_t - y_t^*)^2$, where α depicts the weight of inflation deviations from the target, $(1-\alpha)$ the weight of the output gap, π_t^{TAR} the inflation target, π_t inflation, and $(y_t - y_t^*)$ the output gap. It is possible to see loss functions also with other variables in literature (see e.g., Kotlán and Navrátil (2003)). The simplest approach would only consider the inflation, whereby the value of the loss function corresponds to the RMSE indicator. Beside the output gap, the loss function may also incorporate exchange rate volatility, interest rate volatility, unemployment, etc. In this paper, we included only the output gap in the loss function. The applied higher weight of inflation as against the output gap reflects the logics of inflation as the main goal of monetary policy. The responsibility of monetary policy to contribute to economic stability has been stipulated in the legislation only as a secondary goal, which is supposed to be met by the Czech National Bank only subject to the fulfilment of its main goal (see section 2(1) of Act No. 6/1993, on Czech National Bank, as amended). The results, however, have been fairly robust with respect of the selection of that parameter. The loss function, moreover, could be changing in time as the composition of the Bank Board was changing.

[12] We applied three estimation methods of the output gap: the simple smoothing with help of the Hodrick- Prescott (HP) filter with the parameter λ=1600, an estimate of the output gap with help of the production function method (see CNB (2005)), and an estimate of the output gap used in the QPM core prediction model, which is executed with help of the Kalman filter method (see CNB (2003)).

results from the structure of the filter, which – beside the development of the GDP – interprets, among other things, also the development of inflation, the low value of which logically implies that the estimated output gap remained in negative values during the period of inflation targets undershooting. This estimate of the loss function applied the weight of the square of inflation deviation α at 0.75; still, calculations of the loss function for other values of the same parameter bring about similar conclusions.

4. INTERNATIONAL COMPARISONS

Our results as presented in the previous section can be compared with the conclusions of the available empirical studies analysing the success-rate of inflation targeting on a broader sample of countries. Roger and Stone (2005) discovered that those countries, which target inflation, were outside the target band (± 1 percentage point wide) for 43.5 % of time, i.e., less often than in the Czech Republic. In countries characterised by declining inflation targets, i.e. in the course of disinflation, however, the band was missed in 59.7 % of cases, i.e. about as often as in the Czech Republic. However, as against the Czech Republic, those deviations from the target were roughly balanced in both directions within the entire sample, and in countries characterised by declining targets, they deflected in the direction of its overshooting. The RMSE of deviations of inflation from the target reached the value of 2.2 % for all countries, and the value of 2.7 % for those countries in the process of disinflation, so that the Czech Republic, for its inflation targeting period as a whole, falls approximately in the middle between those two values.

Bulíř et al (2007) analysed a sample of countries made up of Chile, the Czech Republic, Hungary, Poland, Thailand, and Sweden. They discovered that those countries were outside the band in 57 % of cases on average, i.e., roughly as often as the Czech Republic. In some countries, target overshooting prevailed (e.g., in Hungary), while some other countries rather experienced its undershooting (the Czech Republic, Poland, Sweden).

The results of the Czech National Bank are therefore roughly comparable to the results reached by those countries, which applied the inflation targeting regime in order to achieve disinflation, namely from the point of view of the frequency of missing the target tolerance band as well as the statistics of the RMSE deviation of inflation from the target. As against this group of the countries, however, the average inflation deviation from the target in the Czech Republic moves in an opposite direction, i.e., in the direction of undershooting, although even such countries can be found.

The success-rate of inflation targeting on a panel of the OECD countries was analysed also, for example, in Johnson (2002), Ball, Sheridan (2003), or in Lin, Ye (2007). Those studies typically compare the development of inflation prior to and after the introduction of inflation targeting against the development of inflation in those countries where inflation targeting was not introduced. While Johnson (2002) finds evidence for arguments that inflation targeting reduced inflation expectations, Ball and Sheridan (2003) show that a higher drop in inflation in those countries, which introduced inflation targeting, was mainly due to their higher initial inflation (the issue of "mean-reversion"). Lin and Ye (2007) confirm this hypothesis; moreover, they complement the model with endogenous selection of the monetary policy regime when inflation targeting is opted for by those countries, which have been facing higher inflation. Applicability of the above-described approaches to the situation in the Czech Republic, and/or in any other countries, which applied inflation targeting in order to achieve disinflation, however, is contentious. All of the above-described studies, in fact, exclude from their analyses those countries where the targets

decreased in the course of time. High initial inflation occurring in various transforming economies may result from a number of factors of administrative nature deserving exemption, such as – for example – deregulation or changes in the indirect taxes so the "mean-reversion" analyses may bring about different outcomes.

It is not intended that this study should evaluate whether inflation targeting represents a suitable instrument in the execution of disinflation, or that inflation targeting was more successful in the Czech Republic than in other countries. Since the Czech Republic represents a small open economy, its development of inflation to a significant extent results from the course of the global economy. In the following text, therefore, we compare the the fulfilment of the target in the Czech Republic and in some selected economies applying inflation targeting (that is, in such economies, which are characterised by similar transmission mechanisms of their monetary policies). If we discovered any common or similar development of inflation deviations from the target in those countries, such finding would support the hypothesis that inflation targets undershooting occurred with the contribution of global shocks and trends, which appeared also in other economies besides the Czech Republic.

This analysis focuses on ten economies, in particular: the Czech Republic, Hungary and Poland representing Central Europe,[13] the eurozone,[14] Sweden and the United Kingdom, which represent the advanced European countries, and Canada and Chile representing America. This set of the countries is then complemented by New Zealand and Israel. Our selection gave preference to small open economies over the large ones (such as – for example – Brazil), and also to those economies that maintained business relations with the Czech Republic; beside "traditional" inflation targeters, we strove to cover especially those countries, which applied inflation targeting for the purposes of achieving disinflation.

Figure 4 shows deviations of quarterly inflation from the middle of the target for the individual economies in the period commencing at the beginning of 1998. At the same time, it depicts the inflation target band in the relevant period. Most economies targeted inflation within the band of ±1 percentage point around the inflation targets; the Czech Republic started with a narrower band of ± 0.5 percentage point, New Zealand, on the contrary, started with a wider band (± 1.5 percentage points) and Israel adjusted its band width twice (once, it narrowed its band from ± 1.5 percentage points down to ± 0.5 percentage point, then it widened it up to ± 1 percentage point). The eurozone reports an asymmetric band, by reporting only its ceiling for the definition of the price stability (up to 2 %).[15] The inflation target increased within the relevant period only in New Zealand where the inflation band was adjusted from 0-3 percentage points to 1-3 percentage points. The Czech Republic, Poland, Hungary, and Israel decreased their targets.

---

[13] Unfortunately, we could not include in our analysis the geographically and historically proximate Slovakia, which had not been explicitly targeting inflation until 2004, when its first target for the end of 2005 was published. Moreover, Slovakia has experienced over time a shift from a symmetric target to an asymmetric, ECB-style target, which – moreover – dropped from up to 2.5% at the end of 2006 to up to 2% at the end of 2007 and in 2008. Therefore, the number of comparable observations is very low.

[14] The ECB is typically not considered as a central bank targeting inflation because it combines an asymmetric target for inflation with a target for the money supply growth. Still, we decided to include eurozone in this analysis because it acts as the most important business partner of the Czech Republic and – moreover – it reflects the monetary policy relevant for the Czech Republic following its future adoption of the euro.

[15] In 2004, the ECB clarified its definition of price stability in that sense that inflation should fluctuate under two percent but close to such level. In this text, for the sake of simplicity, we considered the value of 2% to represent also the middle value of the band for the eurozone.

The targets currently stand either at the level of 2 percentage points (Sweden, United Kingdom, Canada, New Zealand, Israel, and the eurozone), or 3 percentage points (Czech Republic, Hungary, Poland and Chile). All economies currently explicitly or implicitly (United Kingdom, Czech Republic) tolerate the band of ± 1 percentage point around the target. Although this band has currently been equally wide for all monitored economies, Figure 4 shows that, in the less advanced economies (Czech Republic, Hungary, Poland, Chile, and Israel), inflation volatility has been significantly higher, which makes target fulfilment more difficult in the longer-run. The first glance at the figure shows that quarterly inflation in the Czech economy never exceed the target band, while inflation appeared more often above the target than under the target in the eurozone. Hungary reported inflation target overshooting, as against Poland, which – together with the Czech Republic – ranks among the most important inflation target undershooters. Inflation in the United Kingdom, as well as in Canada and New Zealand, diverted from the band only in exceptional cases. On the contrary, inflation in Israel and in Chile, due to its high volatility – was moving away from the target band relatively often. Among the advanced economies with lower inflation volatility, Sweden reported certain asymmetry of deviations of inflation from the target.

A simple t-test of symmetry of deviations of inflation from the target[16] shows that the Czech Republic, together with Poland, Sweden, and Israel, was undershooting inflation targets in a statistically significant manner; target overshooting occurred in Hungary and New Zealand (see Table 3). As far as the ECB, Canada, the United Kingdom, and Chile are concerned, it is not possible to reject the hypothesis about symmetric deviations of inflation from the target.

Table 3: Tests of symmetric deviations of inflation from the target

	CZ	ECB	POL	HUN	SWE	UK	CAN	Chile	NZ	Israel
t-statistics	-6.27	-0.78	-4.78	1.96	-5.39	-1.15	1.25	0.85	2.51	-2.33
p-value	0.00	0.44	0.00	0.06	0.00	0.25	0.40	0.22	0.02	0.03

Table 4: Target fulfilment in the individual countries

	Countries with declining target				Countries with constant target						Total	Declining target	Const. target
	CZ	POL	HUN	Israel	Chile	SWE	UK	CAN	ECB	NZ			
No. of observations	36	27	23	39	39	39	38	38	39	37	355	124	231
Average	-1.94	-1.44	0.92	-0.91	0.26	-0.86	-0.08	0.11	-0.06	0.44	-0.36	-0.98	-0.04
Median	-1.50	-1.60	0.17	-1.39	0.40	-1.00	-0.11	0.19	0.04	0.54	-0.22	-1.30	0.02
Standard deviation	1.83	1.57	2.26	2.43	1.31	1.00	0.42	0.83	0.50	1.06	1.62	2.27	0.99
Skewness	-0.98	0.51	0.73	0.57	-0.52	0.03	0.32	0.55	-0.84	-0.59	-0.20	0.50	-0.20
Minimum	-6.29	-4.20	-2.43	-4.88	-3.70	-3.10	-0.75	-1.23	-1.18	-2.01	-6.29	-6.29	-3.70
Maximum	0.54	1.50	5.58	4.21	2.85	1.00	0.84	2.48	0.90	2.48	5.58	5.58	2.85
RMSE	2.50	2.11	2.39	2.57	1.32	1.34	0.42	0.83	0.49	1.12	1.66	2.47	0.99
Relative frequency (in %)													
under target middle	91.4	82.0	30.4	71.8	46.2	82.1	55.3	39.5	41.0	29.7	57.1	71.8	49.1
within band	34.0	15.0	48.0	28.0	67.0	54.0	100.0	78.0	41.0	62.0	54.2	30.6	67.0
outside band	66.0	85.0	52.0	72.0	33.0	46.0	0.0	22.0	59.0	38.0	45.8	69.4	33.0
under band	66.0	70.0	17.0	51.0	10.0	46.0	0.0	11.0	0.0	8.0	26.8	53.2	12.6

Table 4 provides some basic statistics on inflation deviations from the targets for the individual economies. Six economies experienced a negative average deviation, among them the Czech Republic with the highest absolute value (-1.9 percentage points). The standard deviation – compared to the Czech Republic – is higher only in the cases of Israel and Hungary. The RMSE indicator applicable to the Czech Republic is comparable to the same indicator for the other economies, which applied declining targets within the relevant period; however, in comparison to the economies with constant or growing targets, the indicators were worse in general.

Beside the assessment of the basic descriptive statistics of target fulfilment, it is fairly important to monitor also the empirical statistical distributions of the deviations of inflation from the target, particularly for those countries, which apply declining targets. This is shown in Figure 5, which presents histograms of inflation deviations from the middle of the target. The histograms for the Czech Republic, Poland, Hungary, Chile, and Israel show that those countries report significant frequencies also in the more distant intervals of the deviation from the target. It is possible to identify a certain multi-peak distribution characteristic for them, which indicates that those countries obviously suffered from a number of major shocks over time. Thus, the interpretation of what a symmetric monetary policy means is fairly complicated for the transition economies, due to the importance of such shocks.

The histograms and also the skewness statistics[17] in Table 4 also show that the presumption of symmetric distribution of deviations of inflation from the target has been violated in some of the countries. This fact may affect the results of the standard t-tests regarding the symmetry of deviations from the targets (violation of the presumption of normal distribution).

If the empiric distribution function skews to the right (i.e. if it has a negative skewness value), it can be relatively easily explained in the case of central banks with asymmetrically defined targets, such as – for example – the ECB, for which an overshooting of the target is less "pleasant" from the communication point of view than an identical undershooting. This situation may give rise to certain asymmetry in responses of the monetary policy and the monitored asymmetric distribution of the deviations of inflation from the target. It is fairly interesting that the Czech Republic reports a similarly "inclined" distribution function as the ECB. A negative skewness value may be given here by implicit asymmetric monetary policy (that is, the central bank assesses target undershooting as less costly that its overshooting, even if its target has been defined as symmetric), which can also be identified, for example, in New Zealand and partially also in Chile. It is also interesting that all of the other countries, which were identified by the t-test as significantly undershooting the inflation target, either reported relatively symmetric distributions of the deviations of inflation from the target (Sweden) or they have this distribution inclined to the other side (Poland and Israel). Asymmetric distribution of the deviations of inflation from the target may be explained in these countries, for example, by the hypothesis of their worries concerning cutting the interest rates below their level in the reference country. An alternative hypothesis may be based on certain worries of very low inflation and its negative impact on the economic growth. A fairly high asymmetry in the distribution of the deviations of inflation from the target (positive skewness) in Hungary may be explained by a not entirely clean regime of inflation targeting in that country (Hungary, beside inflation, also targeted the exchange rate in the past, and it preferred in several cases the maintenance of the exchange rate within the fluctuation band to the fulfilment of the inflation targets).

---

[16] The test based on t-statistics and the presumption of an independent normal distribution (therefore, it does not consider any auto-correlation of the inflation deviations from the target – discussion relating to the Czech Republic is in Section 2 – or potential violation of normality of their distribution – see below in this part of the text). The higher the absolute value of the t-statistics (and/or, the lower the p-value), the higher the probability of the rejection of the hypothesis about symmetric deviations of inflation from the target.

[17] Positive skewness means that the distribution function is inclined to the left, while negative skewness means that the distribution function is inclined to the right. With symmetric distribution, such as normal distribution, the skewness equals to zero.

**Figure 4: Inflation deviations from the middle of the target**
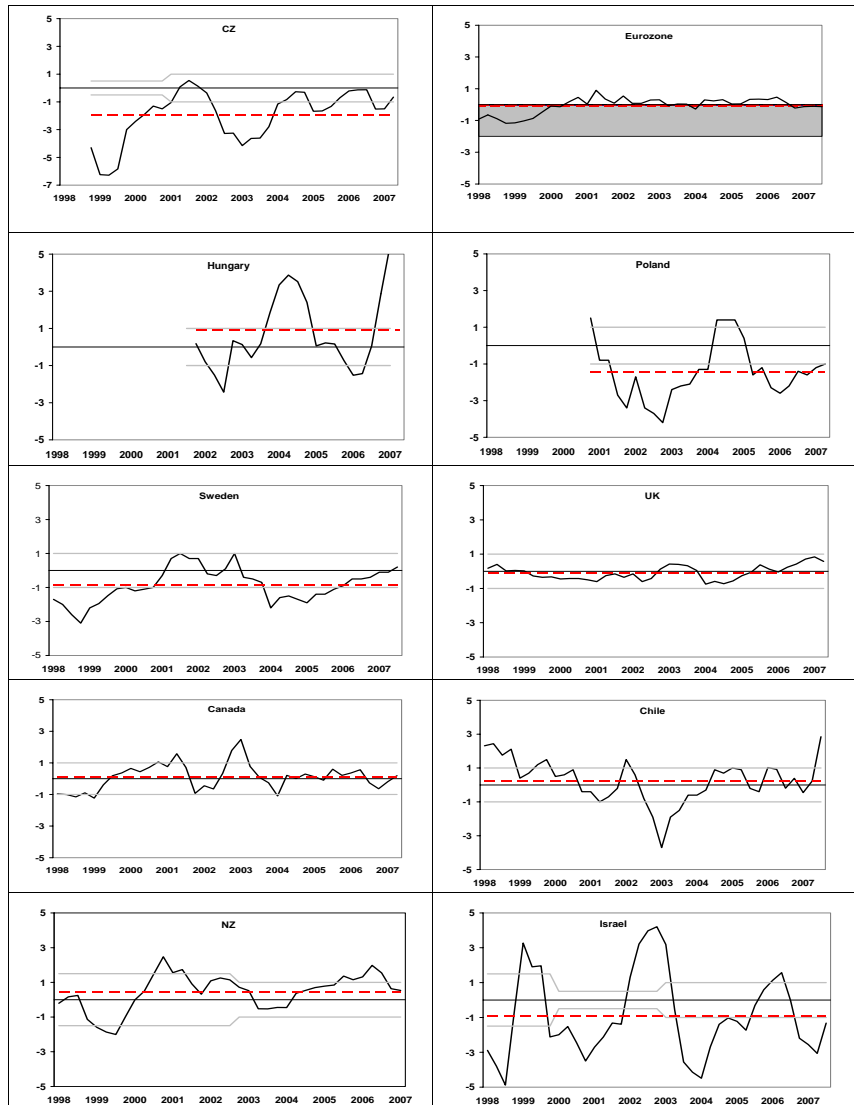
Note: The solid black line marks the deviation of inflation from the target, the grey line marks the tolerance band around the middle of the target, and the dashed red line marks the average deviation for the entire period. The "shading" of the band for the Eurozone reflects the asymmetric nature of its target (inflation under 2%). For the purposes of this analysis, the ECB target is presumed at 0-2%.

Figure 5: Histograms of deviations of inflation from the middle of the target
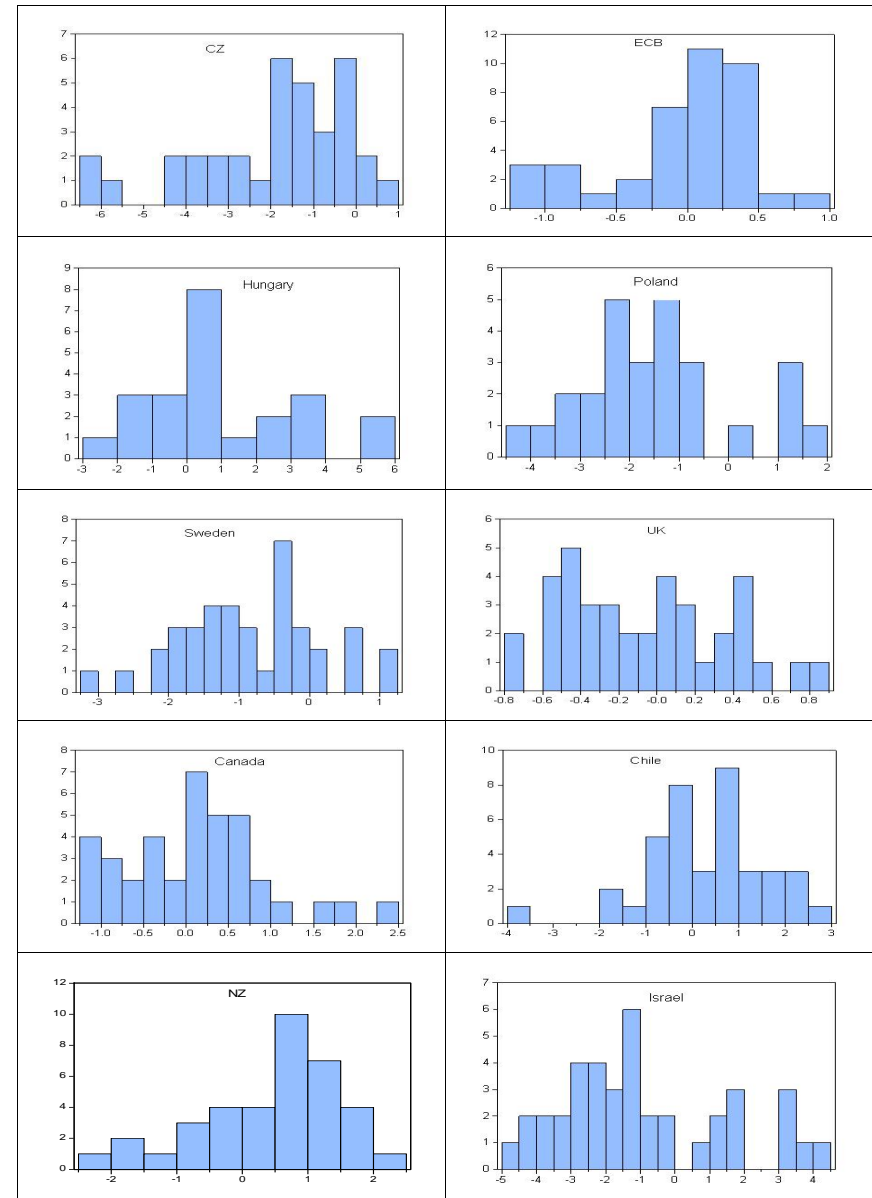
Although undershooting of the inflation targets in the Czech Republic is to a certain extent specific as regards its distribution function, the development of the indicators of the target undershooting for the entire group of the ten monitored economies (see Figure 6) shows that the development in the Czech Republic fits fairly well in the international context. The group of the monitored countries was on average undershooting inflation targets in the years 1998-2007, which is in line with the generally accepted opinion that the period of the past ten years represented a major weakening of the global inflationary pressure. The periods of the most extensive target undershooting in the Czech Republic (the years 1998 to 1999 and 2002 to 2003) also correspond fairly well with the periods characterised by the most negative deviations of inflation from the targets in the group of the monitored economies, as well as with the increased ratio of the countries whose inflation appeared under the target in those periods. It seems, therefore, that the Czech Republic, at least to a certain extent, suffered from some global anti-inflation shocks at those times, which were multiplied by the specific transformation nature of the Czech economy and the development of the exchange rate.

Figure 6: Target fulfilment across the countries (evolution in time)
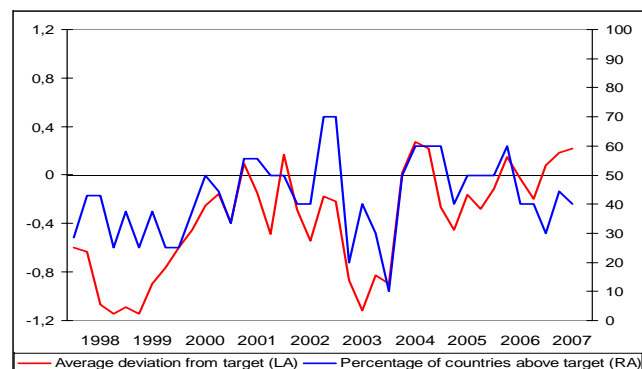
5. CONCLUSION

The challenges related to the fulfilment of the monetary policy goals concentrated into two periods (1998-99 and 2002-03) in the Czech Republic, which were characterised by exchange rate appreciations that the monetary policy could not (or did not intend to) respond to sufficiently quickly and resolutely. A comparison of the characteristics of inflation targets fulfilment for various phases of inflation targeting shows that the success rate of the target fulfilment changed in time. While the inflation deviations from the target were very high in the initial phase of the inflation targeting in international comparisons, lately, the Czech National Bank was nearing the characteristics of relatively more successful inflation targeters. The Czech National Bank does not stand out significantly from among the group of the central banks belonging to the inflation-targeting emerging market economies from the point of view of the frequency and extent of missing the target tolerance band.

REFERENCES

BALL, L. AND N. SHERIDAN (2003): "Does Inflation Targeting Matter?" IMF Working Paper 03/129.

BULÍŘ, A., K. ŠMÍDKOVÁ, V. KOTLÁN, AND D. NAVRÁTIL (2007): "Inflation Targeting and Communication: Should the Public Read Inflation Reports or Tea Leaves?" CNB Working Paper No. 14.

DĚDEK, O. (2000): "Příčiny a průběh měnových turbulencí v české ekonomice v roce 1997 (Causes and Course of Monetary Turbulence in the Czech Economy in 1997)," *Politická ekonomie*, č. 5, str. 605-621 a č. 6, str. 739-763.

CNB (1998-2007): "Inflation Reports," http://www.cnb.cz/en/monetary_policy/inflation_reports/ index. html.

CNB (1999): "Dlouhodobá měnová strategie (CNB Monetary Strategy document)," a document discussed by the CNB Bank Board on 8 April 1999, http://www.cnb.cz/en/monetary_policy/ strategic_ documents.

CNB (2001): "Stanovení inflačního cíle pro období 2002–2005 (The setting of the inflation target for 2002 – 2005)," http://www.cnb.cz/en/monetary_policy/strategic_documents.

CNB (2002): "Strategie řešení kursových dopadů přílivu kapitálu z privatizace státního majetku a z dalších devizových příjmů státu (Strategy for Dealing with the Exchange Rate Effects of Capital Inflows from Privatisation of State Property and from Other Foreign Exchange Revenues of the State)," selected parts from a material approved by the Government at its session on 16 January 2002, http://www.cnb.cz/en/monetary_policy/strategic_documents.

CNB (2003): "The Czech National Bank's Forecasting and Policy Analysis System".

CNB (2004): "Economic Research Bulletin," Special Issue on Inflation Targeting, No. 1, Vol. 2, May 2004.

CNB (2005): "Economic Research Bulletin," Special Issue on Bussiness Cycle Estimation, No. 1, Vol. 3, May 2005.

CNB (2008): "Economic Research Bulletin," Special Issue on 10Years of Inflation Targeting, No. 1, Vol. 6, April 2008.

CNB (2008): "Records from the Sessions of the Bank Board," http://www.cnb.cz/cs/menova_politika/ br_zapisy_z_jednani.

GERŠL, A. AND T. HOLUB (2006): "Foreign Exchange Interventions under Inflation Targeting: The Czech Experience," *Contemporary Economic Policy*, Vol. 24, No. 4 (October), pp. 475–491.

HOLUB, T. AND J. HURNÍK (2008): "Ten Years of Czech Inflation Targeting: Missed Targets and Anchored Expectations", *Emerging Markets Finance and Trade*, Vol. 44, November/ December forthcoming.

JOHNSON, D. (2002): "The effect of inflation targeting on the behavior of expected inflation: evidence from an 11 country panel," *Journal of Monetary Economics* 49, pp. 1521-1538.

KOTLÁN, V. AND D. NAVRÁTIL (2003): "Inflation Targeting as a Stabilisation Tool: Its Design and Performance in the Czech Republic," *Finance a úvěr – Czech Journal of Economics and Finance*, Vol. 53, No. 5-6, p.p. 220-242.

LIN, S. AND H. YE (2007): "Does inflation targeting really make a difference? Evaluating the treatment effect of inflation targeting in seven industrial countries," *Journal of Monetary Economics* 54 (2007), pp. 2521-2533.

ROGER, S. AND M. STONE (2005): "On Target? The International Experience with Achieving Inflation Targets," Washington, D.C., IMF Working Paper, no. 05/163 (August 1).

ŠMÍDKOVÁ, K., ET AL. (1998): "Koruna Exchange Rate Turbulence in May 1997," CNB Working Paper No. 2.