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Monetary Policy Transparency in Inflation Targeting Countries: the  
Czech Republic, Hungary and Poland

*Warsaw, June 2004*

Materials published here have a working paper character. They can be subject to further publication. The views and opinions expressed here reflect the author(s) point of view and not necessarily those of the CASE.

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## **Abstract**

This paper quantifies transparency of monetary policy in the three EU New Member States that have adopted direct inflation targeting strategy. Two measures of transparency are applied. The institutional measure reflects the extent to which a central bank discloses information that is related to the policymaking process. The behavioural measure reflects the clarity among the financial market participants about the true course of monetary policy. The paper shows an ambiguous association between the two measures of transparency, which may be attributed to the active exchange rate management policy that undermines the actual transparency proxied by the behavioural measure.

## 1. Introduction

The main objective of this study is to evaluate monetary policy transparency in the three European Union (EU) New Member States (NMS) that have adopted direct inflation targeting (DIT) strategy, i.e. the Czech Republic, Hungary and Poland. The common challenge for these NMS is to meet the Maastricht criteria and to harmonise their monetary policies with that of the European Central Bank (ECB) on their road to the European Monetary Union (EMU). The main presumption of this paper is that the EMU candidates need to foster monetary policy transparency to the degree commensurate with that followed by the ECB. In this sense, reaching a comparable degree of transparency can be viewed as a critical criterion of a successful monetary convergence to the euro. The ECB transparency, therefore, serves as a benchmark for evaluating our results. The ECB does not follow the DIT strategy, nevertheless it has a well-prescribed inflation target and its policy is considered seemingly transparent.

For the purpose of our analysis, we define transparency as a far-reaching communication of monetary policy goals, strategies and operational tactics to the public at large. We evaluate two aspects of transparency: the institutional and the behavioural. The institutional transparency is understood as the extent to which central bank discloses information that is related to the policymaking process, and the behavioural transparency is defined as the clarity among financial market participants about the true course of monetary policy. We further analyse the link between the institutional and the behavioural transparency and we put forth some hypothesis explaining a seemingly weak association between the two.

We measure the institutional transparency by employing the methodology of Eijffinger and Geraats (2002). By adopting their survey questions we obtain the Eijffinger and Geraats (EG) index for the three NMS. The behavioural measure is based on the econometric model originally proposed by Haldane and Reed (2000) and modified in our study to account for specific conditions of the three NMS. We believe that our dual approach to measuring monetary policy transparency brings a new dimension to the literature addressing various aspects of monetary convergence to the EMU.

The paper is organised as follows. Section 2 elaborates on theoretical foundations of monetary policy transparency with distinguishing between the institutional and behavioural measures. Section 3 presents the empirical investigation of the institutional transparency by assessing information disclosure patterns. Section 4 measures the behavioural transparency and Section 5 examines the link between both measures. Section 6 encapsulates our findings.

## **2. Theoretical Underpinnings of Monetary Policy Transparency**

In general terms, transparency of monetary policy can be ascertained as a degree of information asymmetry between the monetary authority and the public at large. Specifically, a transparent central bank is prone to disclose full information about the policy goals, strategies and tactics (Bernanke, et. al., 1999) as well as modelling assumptions, methods, and official forecasts. By doing so, it diminishes the degree of asymmetric information relative to the public at large.

In essence, transparency is considered an important feature in the design of a modern central banking (Chortareas et al., 2003). According to the survey results of 91 central banks conducted by Fry et al. (2000), 74% of them consider transparency as important or very important. This importance is also underscored by the IMF (1999) in its “Code of Good Practices on Transparency in Monetary and Financial Policies”.

This perception is understandable given potential benefits from diminishing the information asymmetry between the monetary authority and the public at large. First, the central bank gains opportunity to match its actions to its public statements, which is an effective venue for strengthening credibility (IMF, 1999). Second, transparency helps align private sector expectations with the official forecasts of inflation and other monetary variables, which reduces their volatility and makes a country’s monetary conditions less risky (Favero et al., 2000). Third, a higher degree of transparency reinforces the expectations channel of monetary policy transmission relative to alternative channels such as the aggregate demand, the exchange rate, etc. (Svensson, 1999). In the context of our research, this gain is particularly important, since the expectations channel plays a pivotal role in the DIT policy framework, thus transparency can be viewed as an important prerequisite for a viable introduction of the DIT (Mishkin, 2000), particularly by the monetary authorities in the transition economies (Orłowski, 2000, 2001).

There are two basic approaches to measuring monetary policy transparency: (1) the institutional approach evaluates the extent of information disclosed by central banks through available documents (Eijffinger and Geraats, 2002) and (2) the behavioural approach takes into consideration the clarity among financial market participants about the actual course of the monetary policy and can be assessed by measuring the impact of policy announcements on market interest rates (Haldane and Read, 2000). We conduct our analysis along both approaches. This allows us to determine the extent to which central banks can improve behavioural transparency and therefore effectiveness of monetary policy by simply changing patterns of information disclosure.

## 2.1. Institutional Transparency: the Eijffinger-Geraats Model

Eijffinger and Geraats (2002) perceive transparency as a multifaceted concept that comprises political, economic, procedural, policy and operational aspects of central banking<sup>1</sup>. These aspects can be illustrated in relation to the simple model of the economy:

$$L = (\pi - \pi^*)^2 + A(y - k\bar{y})^2 \quad (1)$$

$$y = \bar{y} - a(i - \pi^E - \bar{r}) + d \quad (2)$$

$$\pi = \pi^E + b(y - \bar{y}) + s \quad (3)$$

$$i = f(\pi, \pi^E, y) + e \quad (4)$$

Equation (1) is the central bank loss function,  $\pi^*$  is the inflation target,  $k\bar{y}$  is the output target,  $\bar{y}$  is the potential level of output,  $k > 1$  represents the political pressure at high levels of output<sup>2</sup>, and  $A$  is the relative weight attached to output stabilisation, that determines the willingness of central bank to allow deviations from inflationary targets (Cukierman, 2001b). Equation (2) characterises the aggregate demand where  $i$  is nominal interest rate,  $\bar{r}$  is long-term interest rate and  $d$  is aggregate demand shock. Equation (3) is a new-Keynesian Phillips curve with the slope determined by  $b$  and supply shock represented as  $s$ . Equation (4) represents reaction function of the central bank that generally should be consistent with its loss function and the structure of the economy, while  $e$  denotes financial shocks leading to the imperfect control of central bank over  $i$ .

Given this set-up, *political transparency* implies openness about policy objectives, including an explicit prioritisation of potentially conflicting goals and quantitative targets or in other words openness about parameters of equation (1). This could be beneficial as formal objectives and quantitative targets might diminish the uncertainty about policymakers' preferences and therefore reduce inflationary bias, as shown by Nolan and Schaling (1996). Also IMF (1999) underlines importance of matching policymakers actions to public statements in order to enhance reputation. Last but not least, institutional arrangements and central bank independence in particular play a crucial role in the evaluation of political transparency as they might be critical for preventing deviations from stated objectives. The evidence of the importance of independence for credibility of monetary policy and price stability is documented, among many others, by Cukierman (1996).

<sup>1</sup> A similar approach is presented by De Haan et al. (2001), although it is less comprehensive and based on arbitrary weighting of responses. Bernanke et al. (1999) evaluate transparency of selected countries in detail and Blinder et al. (2001) offer informal discussion of transparency of major central banks. These studies do not provide common criteria for measuring and comparing transparency across countries. Fry et al. (2000) construct an index of 'policy explanations' for 91 central banks; however, since it is constructed on the basis of central banks survey, it may lead to biased results. Finally, there are number of studies that measure transparency along one selected dimension, for example, Chortareas et al. (2001) focus exclusively on the degree of detail of published forecasts in their survey of 87 countries.

<sup>2</sup> This can be attributed to the political cycles driven by elections (Blanchard and Fischer, 1989) that can create pressure on the government to support targeting output above the natural rate (Alesina, 1988).



*Economic transparency* relates to economic information underlying monetary policy including the available economic data, employed policy models and the internal forecasts that the central bank relies on. In other words it involves the symmetric information about both economic variables and structural parameters in equations (2) and (3). According to Tarkka and Mayes (1999) monetary policy is more predictable due to release of central bank forecast. Furthermore, Geraats (2000) shows that the publication of comprehensive central bank forecasts or its economic model facilitates reputation building while at the same time allowing for greater flexibility to stabilise economic shocks. Geraats (2001) argues that “Only perfect transparency about economic information completely eliminates the inflation bias”. Chortareas et al. (2002) find that the greater degree of detail in the central banks’ published forecasts is associated with lower average inflation. In a different vein, Gersbach (1998) and Cukierman (2001a) find that greater economic transparency has a negative impact on stabilisation effectiveness in the absence of preference uncertainty. Geraats (2002b) also argues that economic transparency might lead to greater political pressure on central bank when its independence is not well established.

*Procedural transparency* denotes openness of decision making process and it might involve policy rule or strategy and also release of minutes and voting records that show the considerations underpinning the decisions. In other words, it involves openness about the functional form of equation (4). Buiters (1999) and Gersbach and Hahn (2001a, 2001b,) seem to suggest the positive consequences of disclosure of non-attributed voting records and minutes, while there is still controversy about the release of attributed documents.

*Policy transparency* involves prompt announcement and adequate explanation of the decision as well as policy inclination to signal possible future actions, i.e. availability of information about  $i$  in equation (2). Tabellini (1987), Dotsey (1987), Rudin (1988), Cosimano and Van Huyck (1993) show that secrecy about short-term monetary targets might either facilitate or impede achievement of monetary objectives depending on the knowledge of the longer-term target and the sophistication in the exchange of information between central bank and private agents. Furthermore, neither the importance of policy explanation nor indication has been unambiguously evaluated in the literature.

*Operational transparency* characterises control errors in implementation of monetary policy and disturbances that affect the transmission of monetary policy or the symmetry in knowledge about shocks  $s$ ,  $d$  and  $e$  in equations (2), (3) and (4), respectively. Faust and Svensson (2002) argue that operational transparency tends to reduce the inflation bias and improve social welfare; however they also show (Faust and Svensson, 2001) that operational transparency is likely to be quite limited in practice. Jensen (2001) argues that although high operational transparency might alleviate the low credibility problem, it may also limit central bank ability to stabilise output.

Eijffinger and Geraats (2002) provide the questionnaire that allows compiling the index that captures all five distinctive categories of transparency discussed above. This questionnaire is utilised in the empirical part of this study and will be discussed further in Section 3.

## 2.2. Behavioural Transparency: the Haldane-Read Model

Haldane and Read (2000) propose a simple theoretical framework underlining the behavioural measure of transparency. This framework is based on the model of monetary policy surprises that captures interactions between the private sector and the monetary authorities. It contains three behavioural equations<sup>3</sup>:

$$x_{t+k} = \alpha x_{t+k-1} + \beta i_{t+m}^c + \varepsilon_{t+k} \quad (5)$$

$$i_{t+m}^c = \delta (x_t - x_t^*) \quad (6)$$

$$E_{t-1} ({}_{t+j}i_{t+m+j}^c) = {}_{t+j}i_{t+m+j/t-1} \quad (7)$$

Equation (5) describes the monetary policy transmission mechanism, in which  $x_t$  stands for a vector of variables that are embedded in a central bank's reaction function<sup>4</sup>,  $k$  is the average transmission policy lag, and  $\beta$  is a coefficient explaining the monetary transmission mechanism<sup>5</sup> and  $i_{t+m}^c$  is the central bank's official interest rate at time  $t$  with maturity  $m$ . Some information asymmetry is assumed, as  $\varepsilon_{t+1}$  ( $i \geq 0$ ) is known only to the monetary authorities at the time preceding decision-making on interest rates. Equation (6) can be perceived as a policy feedback rule that specifies coefficient  $\delta$  reflecting discrepancies between the vector of feedback variables and the vector of policy targets.<sup>6</sup> Future policy targets  $x_{t+i}^*$  ( $i \geq 0$ ) that are not known to the private sector agents create another source of information asymmetry. The private sector determines the yield curve reflecting a predicted path of future official interest rates based on the expectations theory of the term structure that is included in equation (7).

The economic rationale behind this model is that the central bank uses equation (5) embedding monetary transmission mechanism to infer  $x_t$  when a shock  $\varepsilon_t$  occurs at the beginning of each period ( $t-1$ ). Subsequently, the central bank sets future policy targets  $x_t^*$ . Since this part of the process cannot be observed by the private sector, predictions regarding a path of official interest rates are based on its own judgements of the current and expected values of  $x_t$  and  $x_t^*$  included in equations (5) and (6). The information about these expectations can be extracted from the yield curve by analysing the forward rates. If a shift in the forward rates occurs following the

<sup>3</sup> Equation (5) can be interpreted as a reduced form of equations (2) and (3); equation (6) restates (4).

<sup>4</sup> These variables can be inflation, output, or employment (Svensson, 1997).

<sup>5</sup> Haldane and Read (2000) assume that  $\beta$  is known for both the central bank and private sector.

<sup>6</sup> It is assumed that both the central bank and the private sector know a parameter  $\delta$ .

decision announcement about official interest rates at time  $t$  relative to  $t-1$  in which the expectations were formed, the sets of feedback variables  $x_t$  and policy targets  $x_t^*$  for the central bank and the private sector were different. This can be interpreted as the lack of transparency that can impair credibility of monetary authorities because they were not able to provide sufficient information about their reaction function and to convince the agents about their commitment to achieving the policy goals. Based on this argument, the econometric analysis of market interest rates responses to changes in official interest rates may provide a useful behavioural measure of transparency. Such analysis is conducted in the empirical section of this paper.

### **3. Institutional Measure of Transparency**

#### **3.1. Eijffinger and Geraats Index for NMS**

In this section we follow the methodology of Eijffinger and Geraats (2002) in order to compile the transparency index for the central banks in the three NMS countries that have adopted DIT strategy. As mentioned above, the EG index captures five distinctive categories of transparency: political, economic, procedural, policy and operational for three central banks in the EU accession. We derive answers to each survey question developed by EG (Appendix 1) from the information published by central banks in NMS and, subsequently, we obtain the set of indices characterising each transparency type. The answers are assigned a score ranging from zero to one. The results of our evaluation are presented in Table 1. They are compared to the ECB benchmark score replicated from EG.

Table 1. EG index for DIT central banks versus ECB

Transparency Criterion	CNB	NBH	NBP	ECB
<b>Political</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
a. Formal Objectives	1	1	1	1
b. Quantitative Targets	1	1	1	1
c. Institutional Arrangements	1	1	1	1
<b>Economic</b>	<b>2,5</b>	<b>3</b>	<b>0,5</b>	<b>2,5</b>
a. Economic Data	0,5	1	0,5	1
b. Policy Models	1	1	0	1
c. Central Bank Forecasts	1	1	0	0,5
<b>Procedural</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>
a. Explicit Strategy	1	1	1	1
b. Minutes	1	0	0	0
c. Voting Records	0	0	1	0
<b>Policy</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>1,5</b>
a. Prompt Announcement	1	1	1	1
b. Policy Explanation	1	0	1	0,5
c. Policy Inclination	0	0	1	0
<b>Operational</b>	<b>2,5</b>	<b>3</b>	<b>2,5</b>	<b>2</b>
a. Control Errors	1	1	1	1
b. Transmission Disturbances	0,5	1	0,5	0,5
c. Evaluation Policy Outcome	1	1	1	0,5
<b>Total</b>	<b>12</b>	<b>11</b>	<b>11</b>	<b>10</b>

Source: Own evaluation based on documents available at official web sites of NMS central banks. The ECB score is replicated from Eiffinger and Geraats (2002).

In evaluating *political transparency* we inquire about the existence of formal objectives, quantitative target and independence (Appendix 1, Question 1). All three central banks in our sample have *formal objectives* for monetary policy; price stability is the main policy objective within the DIT strategy. The *quantitative target* for the price stability is also explicitly specified in all examined NMS. Finally, all of them have a guaranteed *institutional independence of central bank from the government*, mostly in the form of explicit instrument independence. In the case of Poland this independence is stated in the constitution and a similar law is being written in the Czech Republic in an effort to bring compliance with the EU law<sup>7</sup>. In sum, all examined central banks are awarded the maximum score on political transparency, which is in line with the ECB benchmark score.

In evaluating *economic transparency* of the surveyed central banks, we focus on three criteria: disclosure of economic data, policy models and official forecasts (Appendix 1, Question 2). To assess the timely *release of economic data*, EG questionnaire looks at the disclosure practice of money supply, inflation, GDP, unemployment rate and capacity utilisation data<sup>8</sup>. These data, with

<sup>7</sup> Formal guarantees of central bank independence in NMS are in fact a reflection of the historically strong political pressures.

<sup>8</sup> Following the discussion of major factors affecting monetary policy action outlined in central bank documents one might argue that some indicators of the fiscal policy stance along with the external imbalance and exchange rate misalignment could be also considered under this category. In fact, the general government balance and the current account data are

the exception of capacity utilisation, are published in every country on at least quarterly basis, either by a central bank or a national statistical office. Estimation of capacity utilisation poses a methodological challenge for countries undertaking major structural change and it is available only for Hungary that receives a full score for this criterion, while the two other NMS receive a reduced score. The second criterion is based on the assumption that in order to interpret the central bank's policy actions it is important to know the *policy models* it employs. Among the three NMS, only the National Bank of Poland (NBP) is yet to publicly disclose a model underlying its policy analysis. Furthermore, NBP does not release numerical *internal forecasts* for inflation and/or output. Since the Czech National Bank (CNB) and the National Bank of Hungary (NBH) publish quarterly forecasts, they receive a full score. In sum, only Poland seems to lag behind the ECB in economic transparency.

To measure *procedural transparency*, we look for central banks description of monetary policy strategy, the publication of minutes and voting records (Appendix 1, Question 3). All central banks in our sample pursue an *explicit monetary policy strategy*, namely the DIT framework. With respect to the *minutes*, the CNB is the only DIT central bank that releases a comprehensive account of policy deliberations within a reasonable amount of time. However, minutes are not detailed and they are non-attributed. Neither the NBH nor the NBP publishes the minutes, although both banks release policy announcement following monthly meetings of their governing councils. The third criterion is based on the assumption that monetary authority should also release *voting records* that would disclose how each decision on its main operating instrument or target was reached. The NBP is the only central bank that publishes attributed voting records. The CNB discloses non-attributed voting records and therefore it scores a half point, while the NBH does not disclose voting records and receives a zero score. In summary, in the category of procedural transparency the NBH is at par with the benchmark score of the ECB that provides neither minutes, nor voting records, while the NBP and the CNB seem to outperform it.

*Policy transparency* entails timely disclosure of policy decisions, its explanation and the future bias (Appendix 1, Question 4). In terms of a *prompt announcement* of monetary policy decisions, all central banks receive a full score. Two of them publish a *policy explanation*, although in different forms. The CNB includes the statement of policy decision in its minutes, while the NBP provides explanation in the press release following each meeting of the Monetary Policy Council. Only the NBH does not provide policy explanation and therefore receives a zero score. The publication of *policy inclination* is not a common practise among the examined central banks, with the exception of the NBP that announces a policy bias, and thus scores a full point. To sum up, in terms of policy transparency the NBP emerges as a leader with a maximum score, followed by the CNB. Both outperform the ECB, which does not provide any policy inclinations and publishes solely a vague policy explanation. Hungary lags behind the two other NMS and the ECB.

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available in each of the examined NMS, at least on a quarterly basis. In addition, the inclusion of other factors such as labour productivity, real wages and unit labour cost could further enhance transparency.

*Operational Transparency* encompasses control errors, transmission disturbances and evaluation of policy outcome (Appendix 1, Question 5). *Control errors* pertain to the degree of achieving the policy operating targets. All central banks provide such evaluation on at least annual basis and get a full score. The second criterion inquires whether the central bank regularly provides information on unanticipated macroeconomic disturbances that affect the policy transmission process. In other words, it tells us whether or not the central bank includes a *discussion of past forecast errors*. Only the NBH includes such discussion, while the CNB and the NBP provide only general assessment of developments in monetary policy transmission mechanism and score half point. The next issue is whether the central bank provides regularly an *evaluation of the policy outcome* relative to its macroeconomic objectives. In this respect all central banks obtain a full score, although their analyses do not appear equally thorough. In summary, all examined central banks seem to be more transparent in evaluating their policy performance than the ECB. This underpins their credibility-building efforts, even though their analyses and policy explanations are often vague - the factor that is not captured by the EG index.

As shown in Table 1, the overall score does not fully reflect the pronounced specific differences in transparency criteria for the individual NMS. Moreover, the results imply that the institutional transparency achieved by all NMS is impressively high and not inferior to that of the ECB. In the following sections we will discuss why such a favourable assessment might be partly misleading, as it does not translate into high behavioural transparency.

### **3.2. DIT Extension of Eijffinger and Geraats Index for NMS**

In this section we dwell further on the qualitative aspects of institutional transparency in the three DIT countries. The EG index does not capture adequately specific features of this policy framework, and, as examined in the literature, the DIT conditions are highly diversified in the individual NMS (Orlowski, 2003). We, therefore, evaluate the monetary regimes in NMS against the DIT blueprint that contains a unique, forward-looking inflation target, specified as a linear trajectory with a continuous target monitoring and adjustment on a rolling basis, and well-prescribed reaction rules on missing the target (Svensson, 1999; Orlowski, 2001; Jonas and Mishkin, 2003). Consistently, we supplement the original EG questionnaire with the DIT-specific questions about a number of policy goals, exchange rate policy, forward-looking character, target specification, trajectory, monitoring, adjustment rules and overshooting procedures. Our extended questionnaire is applied to the three NMS as well as to the ECB, answers to each question are evaluated on the scale zero to one and the results are reported in Table 2. The results for NMS are benchmarked against the ECB score in our analysis.

**Table 2. Extending EG index: Transparency under DIT**

	CNB	NBH	NBP	ECB
Unique goal	1	0	1	1
Exchange rate policy	0.5	0	1	0.5
Forward/backward	1	1	0	1
CPI or core inflation	1	1	1	1
Trajectory	1	0.5	1	1
Quarterly rolling basis	1	0	0	1
Target change	0.5	0.5	0	0.5
Missing the target	0.5	0	0	0
<b>Total</b>	<b>6.5</b>	<b>3</b>	<b>4</b>	<b>6</b>

Source: Own evaluation based on documents available at official web sites of NMS central banks and the ECB.

The first criterion contains a fundamental question whether the inflation target constitutes the *unique goal* of monetary policy. The CNB and the NBP receive a full point, as they do not specify other explicit goals beyond the one stated in the DIT strategy. On the contrary, the NBH is still targeting the exchange rate band in addition to the inflation target thus it scores zero. The ECB receives a full point since it follows a clearly predetermined inflation target of maximum two percent inflation based on the harmonised CPI.

Large-scale *interventions in the foreign exchange market* conducted within active exchange rate policy constitute potential sources of non-transparency in the implementation of the DIT strategy. The NBP is the only examined bank that does not intervene in the foreign exchange market and thus receives a full score. The CNB that has engaged only in small-scale interventions receives a half-point, while the NBH receives no point for its heavy interventions. While the ECB intervenes infrequently and on a relatively small scale, it scores a half point.

Next, we evaluate the *conformity of policy rule with DIT strategy*. According to Rudebusch and Svensson (1999), inflation forecast targeting requires the policy instrument to be adjusted in such a way that a conditional inflation forecast (the intermediate target variable) hits the inflation target at an appropriate level. The ECB emphasises the forward-looking character of conducted policies, but only the NBH and the CNB formulate their monetary policy based on such a forward-looking rule, which also implies publishing the inflation forecasts. Both central banks publish a discussion about the outlook for the main determinants of inflation, taking into consideration the upside and downside risks of missing the target. Consequently, they receive a full score. The NBP does not release forecasts, and thus it does not conform to the forward-looking policy rule.

The next question deals with the choice of the inflation target. Core inflation has in principle the advantage of greater stability and smaller vulnerability to shocks. Using core inflation will reduce the danger of missing the target due to price volatility that is outside the scope of monetary policy. However, there are also substantial drawbacks of adopting core inflation as a target, as it does not

encompass adjustments in administratively regulated prices. Also, core inflation indexes have not proved to be more stable than the headline index in transition countries (Jonas and Mishkin, 2003). The main argument in favouring CPI over core inflation as a policy target is that the private sector customarily uses it as a basis for forming inflation expectations. The ECB and all analysed central banks specify their *policy target* on the basis of the headline CPI<sup>9</sup>. In addition, all banks employ various measures of core inflation to the price changes that they can influence. The CNB used to employ net inflation as its main analytical and communicative indicator of inflation; however it has switched to targeting headline inflation since April 2001. All central banks receive a full score.

The following criterion is based on the assumption that the inflation targeting central bank should announce *target trajectory*. Only CNB and NBP release information about pursuing inflation target trajectory for the medium-term. They apply the target trajectory for headline inflation by means of a continuous band. We assign a half point to NBH that provides operating year-end targets for the next two years, as well as the ultimate target of 3 percent to be met by 2005 instead of a continuous band.

The next criterion informs us whether a central bank employs a *rolling basis for quarterly assessment of target fulfilment*. The two central banks that meet this standard are the CNB and the NBP, as indicated in their Inflation Reports. The NBH receives no point, since it follows the year-end targets only, in spite of publishing a target trajectory for the medium-term. We note that the practice of the ECB is to provide such assessment monthly.

We assign a half point to the CNB and NBH for an *ex post target change* of the inflation target. Neither of these countries explicitly excludes a possibility of a target change but such action has never taken place since the introduction of DIT. The same assessment applies to the ECB. The NBP has an inclination to change the inflation target when meeting it becomes problematic (as in 1999 and in 2002) and therefore receives no point.

Achieving the inflation target is the main factor determining the decision-making process with respect to changes in monetary policy instrument at any stage. Nonetheless, it should be taken into account that in reality a number of exogenous shocks or unforeseen events can occur whose causes remain fully or predominantly outside of monetary policy control. Accordingly, it would be economically irrational and costly for monetary policy to attempt to correct or eliminate the consequences of such shocks on a short-term basis. Thus, it is extremely important for monetary authorities pursuing DIT strategy to work out *target overshooting procedures*. Only the CNB obtains a half point for releasing precisely defined escape clauses. Such clause is also missing in the case of the ECB.

In contrast to the index constructed on the basis of EG, this extended evaluation shows that there are marked differences in institutional transparency among the three central banks. The CNB policy appears to be the most transparent as it is the only NMS central bank that outscores the

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<sup>9</sup> More precisely, the ECB inflation target is based on the Harmonised Index of Consumer Prices for the euro area.



ECB. The overall scores of NBH and NBP lag behind. It shall be noted, however that the NBP scores relatively better on questions related to the exclusivity of inflationary goal, while the NBH on the forward-looking character of the policy.

#### **4. Behavioural Measures of Transparency: Empirical Results**

In this section we test whether the monetary policy in the three NMS that have adopted DIT is transparent based on the observed dynamics of financial markets. Under a transparent policy financial market participants have clarity about the true course of the monetary policy, consequently market interest rates closely follow the official rates. We also ask whether the introduction of DIT strategy actually increased such defined behavioural transparency. In order to address these issues we estimate how short-term money market interest rates react to changes in official interest rates. This methodology follows Haldane and Read (2000) who argue that in a transparent monetary policy regime, short-term interest rates anticipate to some extent changes in official rates. The argument relies on information asymmetry and the existence of a stationary stochastic equilibrium with full knowledge of the authorities' reaction function<sup>10</sup>. The original econometric model proposed by Haldane and Reed (2000) is as follows:

$$\Delta_{t+j}i_{t+m+j} = \alpha_j + \beta_j(L)\Delta_{t+j}i_{t+m+j} + \gamma_j\Delta_t i_{t+m}^c + \delta_j D_j \Delta_t i_{t+m}^c + e_{t+m+j} \quad (8)$$

for  $j=1,3,6,24,60,120,240$ , where  $j$  stands for maturity of the forward rate expressed in months and  $t$  is a time index. It assumed that  $m=1$ , as the main instrument, usually affects monthly money market rate.  $\beta(L)$  is a vector of polynomial lag operator ( $L$ ). The lagged dependent variables are used to remove autocorrelation, whereas  $D$  is a regime-shift dummy variable aimed at capturing an introduction of DIT strategy. Both variables are specified in first differences in order to examine contemporaneous movements in interest rates. We modify the original specification because the markets for forward interest rates are underdeveloped in NMS. Thus the specification that is employed in the model excludes forward interest rates and embeds short-term money market interest rates. The modified equation can be expressed as follows:

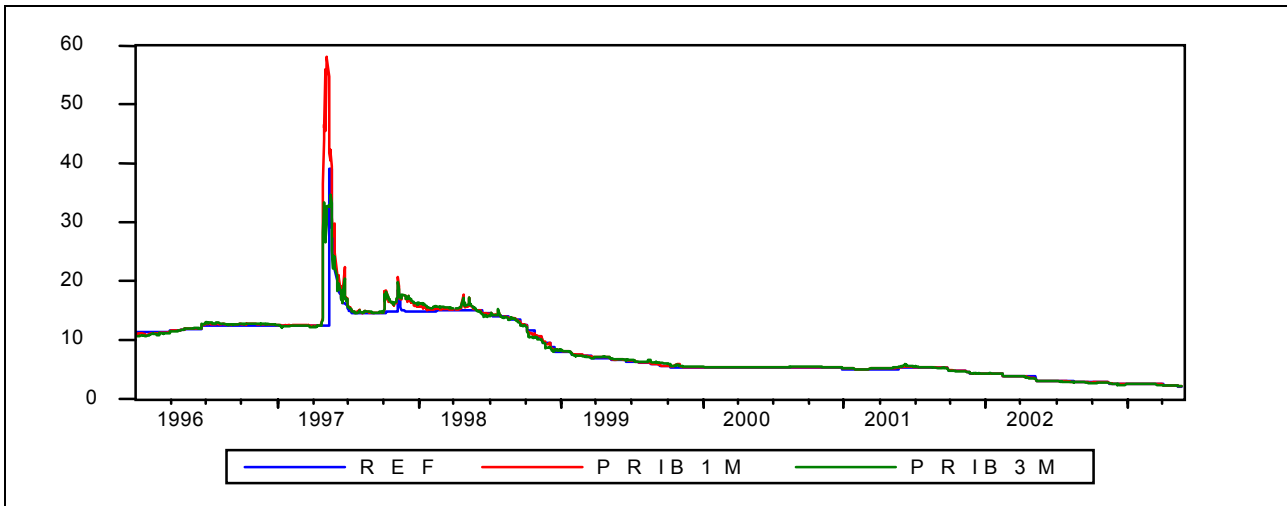
$$\Delta i_{t,j} = \alpha + \beta_j(L)\Delta i_{t,j} + \gamma_j\Delta i_t^c + \delta_j D_j \Delta i_t^c + \varepsilon_t \quad (9)$$

Our econometric analysis is based upon the data on official interest rates downloaded from the CNB, the NBH, and the NBP web sites as well as the data on money market interest rates

<sup>10</sup> The original idea of Haldane and Read (2000) is "to extract measures of interest rate surprises along the yield curve". Therefore, the authors also examine whether the monetary policy is credible by looking at the long-end of the yield curve. This approach is however not feasible in the case of analysed NMS, as they had to bring inflation down (which has shifted their yield curves significantly over the last decade) and as they lack developed forward rates market. These factors could lead to misleading results in evaluation of credibility, but are not essential in the valuation of transparency that is the focus of this research.

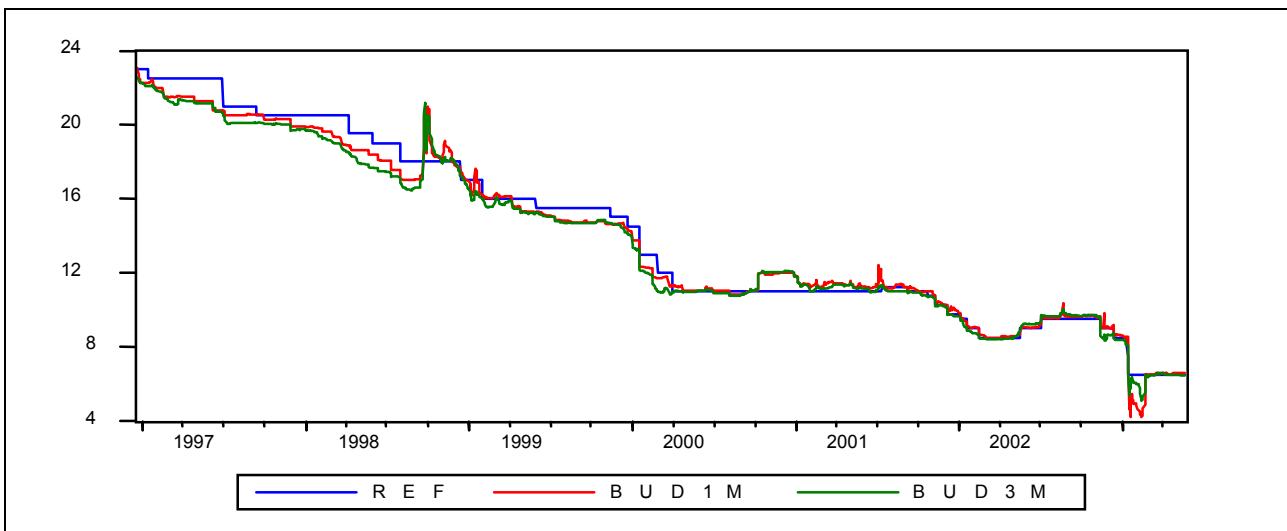
obtained from the Reuters Database and the EcoWin Database.<sup>11</sup> The time series that are used in the estimations are sampled daily and cover the period of January 1, 1996 to July 21, 2003 for the Czech Republic, December 25, 1996 to May 23, 2003 for Hungary, and March 2, 1998 to May 23, 2003 for Poland. The graphical presentation of the data series for the three NMS and the ECB is shown in Figures 1-4.

**Figure 1. The Czech money market rates and the official interest rates**



Note: The main instrument of the CNB monetary policy is a two-week repo rate through which it affects the money market rates, i.e. 1-month, 3-month, and 6-month PRIBOR (Prague Interbank Offering Rate).

**Figure 2. The Hungarian money market rates and the official interest rates**

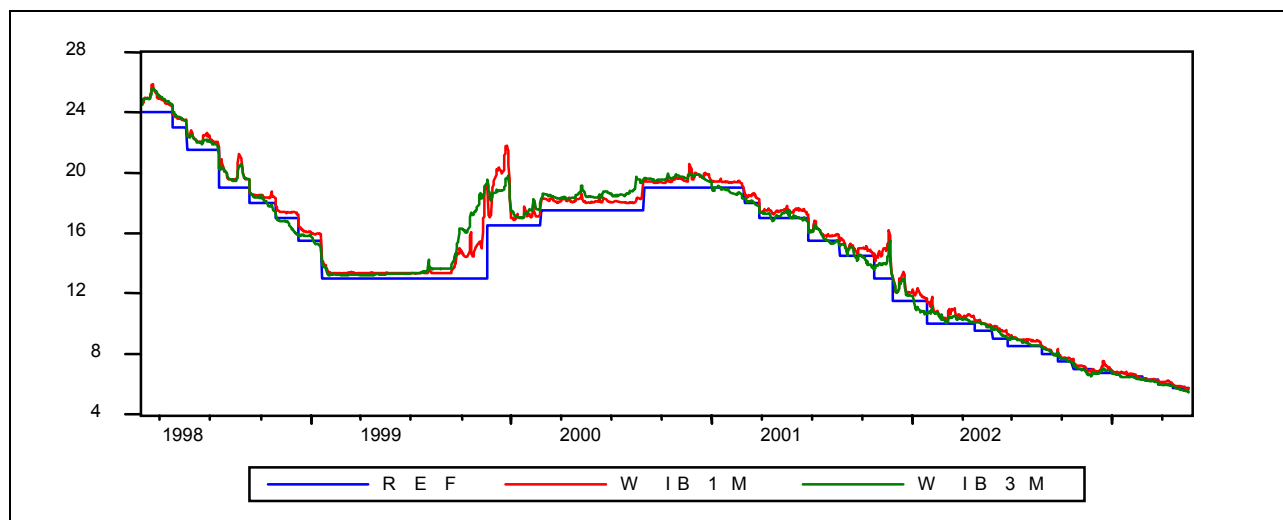


Note: The main instrument of the NBH monetary policy is a two-week refinancing rate through which it affects its money market rates, i.e. 1-month and 3-month BUBOR (Budapest Interbank Offering Rate).

Source: EcoWin, Reuters, and MNB

<sup>11</sup> The authors would like to gratefully acknowledge helpful comments on the data and financial markets developments in NMS received from Rafal Benecki of the Bank Millennium and Radomir Jac of the Commerzbank Securities.

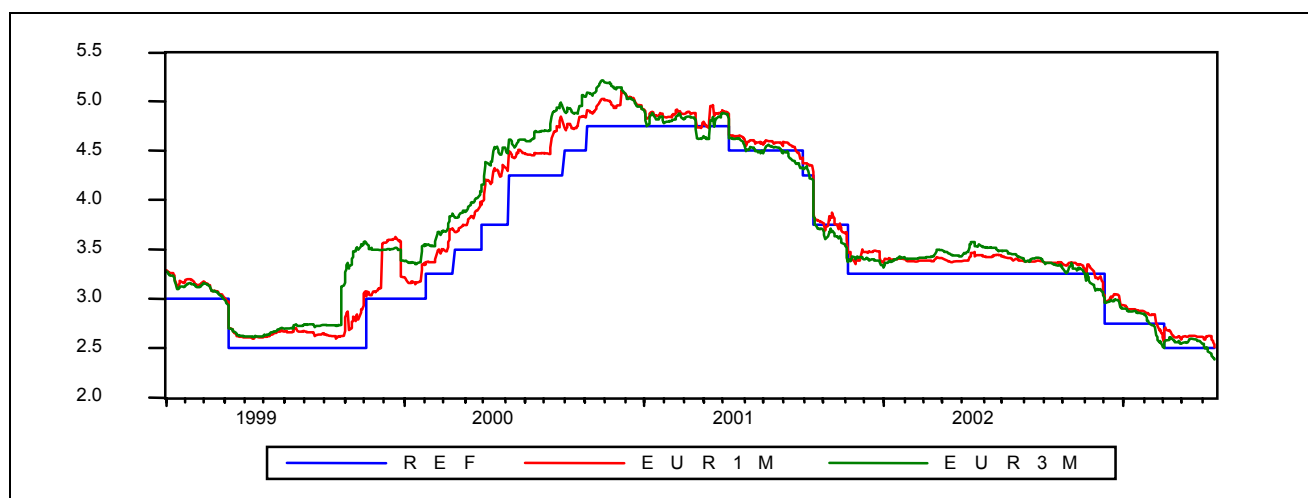
**Figure 3. The Polish money market rates and the official interest rates**



Note: The main instrument of the NBP monetary policy is two-week reference rate (money market intervention rate) through which it affects its money market rates, i.e. 1-month and 3-month WIBOR (Warsaw Interbank Offering Rate).

Source: EcoWin, Reuters, and NBP

**Figure 4. Money market rates and the ECB official interest rate**



Note: The main instrument of the ECB monetary policy is a one-week refinancing rate through which it affects its money market rates, i.e. 1-month and 3-month EURIBOR (Euro Interbank Offering Rate).

Source: EcoWin, Reuters, and ECB

The econometric estimation of the Equation (9) at the short-end of the yield curve<sup>12</sup> provides the evidence of a substantial improvement in transparency of monetary policy conducted by the CNB and the NBP (Table 3). The coefficients for the variables measuring reaction to changes in the official repo rate are statistically significant and their magnitudes are smaller during the DIT

<sup>12</sup> Detailed results are provided in the annex.

period. This improvement confirms expectations about positive results of enhancement in communication strategy and quality of analytical publications since the introduction of the DIT that seemingly allowed for more clarity about central banks reaction functions among financial market participants. Based on lower values of estimated coefficients  $\gamma$  and  $\delta$  for Poland one can draw a conclusion that the NBP is more transparent than the CNB. This is somewhat puzzling given the higher CNB scores on institutional transparency. However, the most transparent is the ECB, due to its parameter  $\gamma$  slightly lower than that of the NBP. Most intriguing are results for Hungary. The empirical evidence suggests a marked decline in the NBH transparency following the introduction of DIT. The NBH transparency is significantly lower than that of NBP or CNB, while under the exchange rate peg it seemed to be very transparent. The noted deterioration in NBH behavioural transparency has taken place in spite of the improvement in information disclosure over the last three years. One may therefore argue that the policies of CNB and, in particular, the NBH that are based on active exchange rate management tend to deteriorate the behavioural transparency.

**Table 3. Empirical results**

		Czech Republic	Hungary	Poland	ECB
	$\gamma$	0.4740	0.5667	0.3199	0.2718
1m	$\delta_1$	0.5311	-0.5478	0.2471	
	$\delta_2$	-0.5493		-0.3831	
	$\gamma$	0.3136	0.5500	0.1848	0.2064
3m	$\delta_1$	0.8336	-0.5346	0.2054	
	$\delta_2$	-0.2116		-0.1528	

Source: own estimations

## 5. The Link Between Institutional and Behavioural Transparency

The behavioural measure of transparency suggests that Poland has the most and Hungary the least transparent monetary policy. These results are not fully consistent with the institutional measure based on EG index, by which CNB appears to be more transparent than its counterparts. The CNB leadership seems to be confirmed by evaluation based on the extended EG index incorporating specific features of the DIT strategy. Based on this extended analysis, the CNB again emerges as the most transparent central bank although this is not confirmed by the behavioural measure.

Looking at individual categories of institutional transparency, the scores are more differentiated. The score for the economic transparency is inconsistent with the behavioural measure; it therefore seems ambiguous whether the publication of the model, capacity utilisation

and even internal forecasts has a significant impact on the behavioural transparency. Moreover, while we strongly believe that the political aspect of transparency, in particular the central bank independence is essential, there is not enough variation in scores among the examined NMS to draw a conclusion about its link to the behavioural transparency. On the other hand, the policy transparency corresponds very well to the ranking of the behavioural measure. This suggests that the policy explanation and the statement of policy inclination may have strongly correlated with the behavioural transparency.

Taking into consideration the extended EG index, the institutional transparency seems to be correlated with the behavioural transparency in terms of the single policy goal and the absence of active exchange rate policy. Poland is leading on both counts. The two other NMS may be suffering from the “fear of floating” that poses a constraint on their policy conduct within the DIT framework. This might be explained by their high degree of openness relative to Poland. As a result, their frequent resorting to foreign exchange market interventions misleads the financial markets and thus inhibits the behavioural transparency. Although the NBP lags behind on some important aspects of DIT – in particular the backward- rather than forward-looking policy rule and the lack of published inflation forecasts, these weaknesses are more than offset by its firm commitment to the inflation goal and refraining from foreign exchange interventions<sup>13</sup>.

In our opinion, it is therefore exactly the uniqueness of goal and absence of active exchange rate policy that crucial in determining the behavioural transparency. However, the analysis of Hungary also suggests that targeting the exchange rate translate into a more transparent monetary policy than targeting inflation when exchange rate policy is not truly abandoned. This finding is potentially important for preparations for accession to the EMU and the preceding participation in the ERM2 as the exchange rate target needs to be given more consideration. This, in turn, may potentially hinder the monetary policy transparency in NMS.

## **6. Concluding Remarks**

Our general finding is that the monetary authorities of Poland, Hungary and the Czech Republic have advanced their monetary policy transparency to the level roughly comparable to that of the ECB. Since transparency improvement can be viewed as an effective venue of enhancing monetary policy credibility, we feel entitled to argue that the NMS central banks are ripe to join the European System of Central Banks as its fully credible members. The demonstrated degree of alignment of monetary policy transparency between the three NMS and the ECB can be also interpreted as a progress on the road to the EMU.

Nevertheless, our examination of the three central banks by the individual criteria of institutional transparency identifies a number of deficiencies that they still need to overcome, in

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<sup>13</sup> This is consistent with the assessment of the success in DIT implementation by Jonas and Mishkin (2003).

spite of their overall success. Specifically, the NBP may improve transparency by increasing reliance of its policy decisions on inflation forecasts and other forward-looking variables, as well as by a public disclosure of its underlying policy model and the official inflation forecast. Both the CNB and the NBP could expand the range of economic data made available for public information. At minimum, the NBH needs to improve its procedural transparency with respect to a public disclosure of minutes and voting records of the governing council meetings. Perhaps more importantly, the NBH could become more transparent if it provided a clear prioritisation of the inflation target over the exchange rate stability goal. In sum, by the institutional definition, the CNB appears to be the most transparent among the examined central banks, even outperforming the ECB. On the behavioural transparency grounds, the NBP emerges as a clear leader. This is a noteworthy accomplishment since it implies an important venue for strengthening credibility and promoting the role of expectation channel in the conduct of monetary policy.

Without doubt, the adoption of DIT strategies by the three examined central banks has contributed to a significant improvement in monetary policy transparency. This improvement is documented by our examination of the behavioural transparency. But in the near future, these NMS will be obliged to join the ERM II on their way to a full adoption of the euro. By doing so, they will have to supplement their predominant inflation target by the exchange rate stability target. It remains to be seen whether such a dual-targeting strategy will dilute their commitment to price stability and, therefore, hinder their monetary policy transparency. In response to such fears, new means of fostering transparency will have to be explored and devised for such a complex, dual-targeting policy framework stemming from the necessity to fulfill the Maastricht convergence criteria.

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## Appendix 1: Eijffinger and Geraats Index Questionnaire

The central bank transparency index is the sum of the scores for the answers to all questions below (min = 0, max = 15). All questions pertain to published information that is freely available in English.

### 1. Political Transparency

Political transparency refers to openness about policy objectives. It comprises a formal statement of objectives, including an explicit prioritisation in case of multiple goals, a quantification of the primary objective(s) and explicit institutional arrangements.

- (a) Is there a formal statement of the objective(s) of monetary policy, with an explicit prioritisation in case of multiple objectives?

No formal objective(s) = 0.

Multiple objectives without prioritisation = 1/2.

One objective, or multiple objectives with explicit priority = 1.

- (b) Is there a quantification of the primary objective(s)?

No = 0.

Yes = 1.

- (c) Are there explicit institutional arrangements or contracts between the monetary authorities and the government?

No central bank, contracts or other institutional arrangements = 0.

Central bank without explicit instrument, independence or contract = 1/2.

Central bank with explicit instrument, independence or contract (although possibly subject to an explicit override procedure) = 1.

### 2. Economic Transparency

Economic transparency focuses on the economic information that is used for monetary policy. This includes economic data, the model of the economy that the central bank employs to construct forecasts or evaluate the impact of its decisions, and the internal forecasts (model based or judgmental) that the central bank relies on.

- (a) Is the basic economic data relevant for the conduct of monetary policy publicly available? The focus is on the following five variables: money supply, inflation, GDP, unemployment rate and capacity utilisation.

Quarterly time series for at most two out of the five variables = 0.

Quarterly time series for three or four out of the five variables = 1/2.

Quarterly time series for all five variables = 1.

- (b) Does the central bank disclose the formal macroeconomic model(s) it uses for policy analysis?

No = 0.

Yes = 1.

- (c) Does the central bank regularly publish its own macroeconomic forecasts?

No numerical central bank forecasts for inflation and output = 0.

Numerical central bank forecasts for inflation and/or output published at less than quarterly frequency = 1/2.

Quarterly numerical central bank forecasts for inflation and output for the medium term (one to two years ahead), specifying the assumptions about the policy instrument (conditional or unconditional forecasts) = 1.

### 3. Procedural Transparency

Procedural transparency is about the way monetary policy decisions are taken. It involves an explicit monetary policy rule or strategy that describes the monetary policy framework, an account of policy deliberations and how the policy decision was reached.

- (a) Does the central bank provide an explicit policy rule or strategy that describes its monetary policy framework?

No = 0.

Yes = 1.

- (b) Does the central bank give a comprehensive account of policy deliberations (or explanations in case of a single central banker) within a reasonable amount of time?

No, or only after a substantial lag (more than eight weeks) = 0.

Yes, comprehensive minutes (although not necessarily verbatim or attributed) or explanations (in case of a single central banker), including a discussion of backward- and forward-looking arguments = 1.

- (c) Does the central bank disclose how each decision on the level of its main operating instrument or target was reached?

No voting records, or only after substantial lag (more than eight weeks)=0.

Non-attributed voting records = 1/2.

Individual voting records, or decision by single central banker = 1.

### 4. Policy Transparency

Policy transparency means prompt disclosure of policy decisions. In addition, it includes an explanation of the decision, and an explicit policy inclination or indication of likely future policy actions.

- (a) Are decisions about adjustments to the main operating instrument or target promptly announced?

No, or after a significant lag = 0.

Yes, at the latest on the day of implementation = 1.

- (b) Does the central bank provide an explanation when it announces policy decisions?

No = 0.

Yes, when policy decisions change, or only superficially = 1/2.

Yes, always and including forwarding-looking assessments = 1.

- (c) Does the central bank disclose an explicit policy inclination after every policy meeting or an explicit indication of likely future policy actions (at least quarterly)?

No = 0.

Yes = 1.

## 5. Operational Transparency

Operational transparency concerns the implementation of the central bank's policy actions. It involves a discussion of control errors in achieving operating targets and (unanticipated) macroeconomic disturbances that affect the transmission of monetary policy. Furthermore, the evaluation of the macroeconomic outcomes of monetary policy in light of its objectives is included here as well.

- (a) Does the central bank regularly evaluate to what extent its main policy operating targets (if any) have been achieved?

No, or not very often (at less than annual frequency) = 0.

Yes, but without providing explanations for significant deviations = 1/2.

Yes, accounting for significant deviations from target (if any); or, (nearly) perfect control over main operating instrument/target = 1.

- (b) Does the central bank regularly provide information on (unanticipated) macroeconomic disturbances that affect the policy transmission process?

No, or not very often = 0.

Yes, but only through short-term forecasts or analysis of current macroeconomic developments (at least quarterly) = 1/2.

Yes, including a discussion of past forecast errors (at least annually) = 1.

- (c) Does the central bank regularly provide an evaluation of the policy outcome in light of its macroeconomic objectives?

No, or not very often (at less than annual frequency) = 0.

Yes, but without providing explanations for deviations = 1/2.

Yes, with an explicit account for deviations between policy outcomes and objectives = 1.

## Appendix 2: Questionnaire Extending EG Index for DIT Countries

1. Is inflation rate target the only goal of monetary policy?

No = 0

Yes = 1

2. Is central bank conducting an active exchange rate policy?

There is exchange rate target or there were major foreign exchange interventions since the introduction of the DIT = 0

There is an exchange rate target or there were limited size interventions since the introduction of the DIT = 0.5

No = 1

3. Is policy rule consistent with forward-looking character of the DIT strategy?

Yes, policy is forward-looking and based on inflation forecasts =1

No, policy is backward looking=0

4. What is policy target?

Core inflation = 0

CPI=1

5. Is trajectory of the target provided?

Only one, short or medium, term targets is specified = 0

There are combined short and medium term targets=0.5

Yes, full target trajectory for the medium term (up to 3 years)=1

6. Is meeting the target assessed on the rolling basis at least quarterly?

No= 0

Yes=1

7. What is the probability of ex-post target change?

Not explicitly excluded and the target has been modified ex-post since the introduction of the DIT=0

Not explicitly excluded, but ex-post target change has never taken place since the introduction of the DIT=0.5

Explicitly excluded=1

8. Are there procedures for the contingency of target overshooting?

No explicit rule = 0

Explicit rule triggered by more than two quarters of target overshooting or precisely specified escape clauses =0.5

Explicit rule (including explanation given to national authorities, redundancy of central bankers, interest action required in order to meet the target) triggered by no more than two quarters of target overshooting =1

## Appendix 3. Econometric Results

Testing for stationarity of the data is omitted mainly due to two reasons: (1) variables are already in first differences to capture interest rate movements rather than general trends in interest rates and (2) the sample period is relatively short. For these two reasons cointegration analysis is also neglected.<sup>14</sup>

The estimation of equation (2) is commenced with checking for structural breaks, heteroskedasticity and serial correlation. We test (2) considering various sample periods that corresponds with major structural changes in the policy environment in the examined countries. At

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<sup>14</sup> Haldane and Read (2000) also neglect checking for the stationarity of the data and the cointegration analysis, although they analyse the period of more than a decade.

no case the differential intercepts prove to be significant, therefore a differential slope coefficient is included.

The White's test for heteroskedasticity in the residuals reveals that for all NMS the null hypothesis of no heteroskedasticity in residuals is rejected for both 1-month and 3-month interest rates. The detection of heteroskedasticity in the residuals means that although the OLS estimators are still linear and unbiased they are no longer efficient, i.e. they are not BLUE. The consequence of this violation is that standard errors,  $t$  statistics and  $F$  statistics are biased, therefore we cannot interpret them (Verbeek, 2004). One of the remedies for the presence of heteroskedasticity may be applying the method proposed by White (1980) who derived consistent covariance matrix estimator allowing to interpret standard errors and the above mentioned statistics unless a problem of a small sample is faced. Therefore, by using this method corrected standard errors and the  $t$  statistics can be obtained.

The second test checks for the presence of serial correlation in the residuals. The Breusch-Godfrey Serial Correlation LM test allows to check for autocorrelation of higher orders and it is still valid if there is a lagged endogenous variable among explanatory variables.<sup>15</sup> The detection of autocorrelation in the residuals for almost all NMS invalidates standard errors and both  $t$ -ratios and  $F$ -statistics. Since we face problems with both heteroskedasticity and autocorrelation of residuals we apply the methodology proposed by Newey and West (1987). This extension of White's procedure provides us with heteroskedasticity-and-autocorrelation-consistent (HAC) robust standard errors as well as well as  $t$ -and  $F$ -statistics (Verbeek, 2004 and Patterson, 2000).

### *Czech Republic*

Three sample periods are chosen following Matousek and Taci (2003), although the null hypothesis of no structural change in the equations explaining 1-month and 3-month interest rates cannot be rejected by the Chow test. However, the null hypothesis is rejected in the case of 6-month interest rate at 1% significance level indicating a structural change in assumed periods. The sample is divided into the following sub-samples: January 1, 1996–March 31, 1997; April 1, 1997–December 31, 1997; and January 1, 1998–May 23, 2003.

**The first period predates the major international financial crisis (the Asian financial crisis),** which by itself is captured by the second period. The 1997 crisis is extracted from the overall sample because it caused significant instability of the Czech financial markets while leaving Polish and Hungarian markets relatively unscathed. The third period follows the crisis and it coincides roughly with the pursuit of the DIT strategy that was enacted by the CNB in January 1998 (Matousek and Taci, 2003). However, one of the drawbacks of the Chow test is that it does not inform whether the structural change is due to a slope coefficient, different intercepts or both. In

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<sup>15</sup> Durbin-Watson statistics cannot be used under these circumstances.

order to address this issue and assess structural characteristics of the three sample periods, the tested form of the model for the Czech Republic (estimated at different maturities) is prescribed as a slightly modified Equation (9):

$$\Delta i_{t,j} = \alpha + \beta_j(L)\Delta i_{t,j} + \gamma_j \Delta i_t^c + \delta_1 D_1 \Delta i_t^c + \delta_2 D_2 \Delta i_t^c + \varepsilon_t \quad (10)$$

where  $D_1$  and  $D_2$  represent dummy variables capturing the first and second sample periods respectively, thus the remaining observations correspond with the third period. The estimation results of Equation (10) for two maturities are presented in Table A.3.1.

**Table A.3.1. Estimation representations of Equation (10) for the Czech Republic**

	Coefficients					adj. R <sup>2</sup>	F-test
	$\alpha$	$\beta_1$	$\gamma$	$\delta_1$	$\delta_2$		
PRIBOR 1m	-0.0013 [0.0193]	0.1194 [0.1480]	0.4740** [0.0789]	0.5311** [0.1123]	-0.5493** [0.1722]	0.0211	11.6661 0.0000
PRIBOR 3m	-0.0024 [0.0092]	0.1572** [0.0780]	0.3136** [0.0753]	0.8336** [0.0969]	-0.2116* [0.1095]	0.0509	27.5505 0.0000

HAC standard errors are reported in parentheses; \* indicates significance at 5%; \*\* indicates significance at 1%, second rows for  $F$ -statistics represent  $p$ -values

Source: Own estimations

The results show that both parameters  $\gamma$  and  $\delta$  are statistically significant, which means that the null hypothesis of zero coefficient is rejected. The interactive dummy variables are also statistically significant. Since estimated  $\delta_2$  coefficients are negative, it can be argued that transparency of the monetary policy has increased after the introduction of DIT.

### Hungary

The empirical test of responses of market interest rates to the official rates in Hungary is based on two sample periods: December 19, 1996–May 3, 2001; and May 4, 2001–May 23, 2003. The point of division reflects the day of the inception of DIT by the NBH. Therefore, the structural analysis reflecting differences in interest rate reactions during these two periods enables to assess contribution of the new policy regime to financial stability relative to the stability under the previous system that was based on exchange rate targeting. Due to the identification of two periods only, the tested function for Hungary is based on Equation (9) to allow for  $D$  to capture the pre-DIT period. The results of the Equation (9) for two maturities are presented in Table A.3.2

The empirical evidence suggests that the NBH is not transparent and there is a marked decline in transparency following the introduction of the DIT, as a parameter  $\gamma$  is significantly different from zero and  $\delta$  is negative.

**Table A.3.2. Estimation representations of Equation (9) for Hungary**

		Coefficients					
	$\alpha$	$\beta_1$	$\gamma$	$\delta_1$	adj. R <sup>2</sup>	F-test	
BUDBOR 1m	-0.0071*	0.1091	0.5667**	-0.5478**	0.0434	26.2798	
	[0.0031]	[0.0836]	[0.1866]	[0.1993]		0.0000	
BUDBOR 3m	-0.0053*	0.2805**	0.5500**	-0.5346**	0.1400	91.6862	
	[0.0024]	[0.0676]	[0.1807]	[0.1816]		0.0000	

HAC standard errors are reported in parentheses; \* indicates significance at 5%; \*\* indicates significance at 1%; second rows for *F*-statistics represent *p*-values

Source: Own estimations

### Poland

The empirical analysis of the model for Poland is based on the extraction of two sample periods: January 1, 1996–June 3, 1998; and June 4, 1998–May 23, 2003. The first sample period predates the announcement of the DIT strategy, while the second period follows it. Thus the tested function for Poland includes one dummy capturing the pre-DIT period. There is also a dummy for the period of the end of 1999 to adjust for a dynamic increase in the market interest rates related to the year 2000.<sup>16</sup>

$$\Delta i_{t,j} = \alpha + \beta_j(L)\Delta i_{t,j} + \gamma_j \Delta i_t^c + \delta_1 D_1 \Delta i_t^c + \delta_2 D_2 \Delta i_t^c + \varepsilon_t \quad (11)$$

where  $D_1$  and  $D_2$  represent dummy variables capturing the regime shift in monetary policy and Y2K problem, respectively. The results of the Equation (11) for two maturities are presented in Table A.3.3.

**Table A.3.3. Estimation representations of Equation (11) for Poland**

		Coefficients						
	$\alpha$	$\beta_1$	$\gamma$	$\delta_1$	$\delta_2$	adj. R <sup>2</sup>	F-test	
WIBOR 1m	-0.0038	0.2504***	0.3199***	0.2471*	-0.3831**	0.2029	87.8142	
	[0.0042]	[0.0648]	[0.1282]	[0.1323]	[0.1274]		0.0000	
WIBOR 3m	-0.0072**	0.2041***	0.1848**	0.2054*	-0.1528**	0.1746	73.1434	
	[0.0033]	[0.0480]	[0.0779]	[0.1105]	[0.0775]		0.0000	

HAC standard errors are reported in parentheses, \* indicates significance at 10%, \*\* indicates significance at 5%, \*\*\* indicates significance at 1%, second rows for *F*-statistics represent *p*-values

Source: Own estimations

<sup>16</sup> Market participants and general public were afraid of problems with liquidity that could occur as a consequence of obsolete software possessed by some banks.

The empirical evidence suggests that the NBP is not transparent because a parameter  $\gamma$  is significantly greater than zero. However, there is a statistically significant increase in transparency in the monetary policy conduct following the introduction of DIT, as  $\delta_1$  is significant at 10% level and has a positive sign.

### ECB

The empirical analysis covers the period of January 1, 1999 – May 23, 2003. The empirical test for the Eurozone does not include a regime shift dummy variable, as there has been no change in the monetary policy strategy of the ECB in the analysed period.

$$\Delta i_{t,j} = \alpha + \beta_j(L)\Delta i_{t,j} + \gamma_j \Delta i_t^c + \varepsilon_t \quad (12)$$

**Table A.3.4 Estimation representations of Equation (12) for the ECB**

	Coefficients			adj. R <sup>2</sup>	F-test
	$\alpha$	$\beta_1$	$\gamma$		
EURIBOR 1m	-0.0005 [0.0009]	0.1094** [0.0315]	0.2718** [0.0975]	0.1331	88.6911 0.0000
EURIBOR 3m	-0.0006 [0.0008]	0.1526** [0.0407]	0.2064* [0.0914]	0.1300	86.3236 0.0000

HAC standard errors are reported in parentheses; \* indicates significance at 5%, \*\* indicates significance at 1%; second rows for F-statistics represent p-values

Source: Own estimations

The empirical evidence suggests that the ECB is not transparent because a parameter  $\gamma$  is significantly greater than zero, although its magnitude is slightly lower than for Poland.