MACROECONOMIC FORECAST RELEVANCE IN THE CENTRAL BANK'S DECISIONS: THE CASE OF EUROPEAN ECONOMIES

Magdalena Szyszko, Aleksandra Rutkowska*

Abstract
We examine central banks' involvement in inflation forecast targeting by means of an index-based analysis and ordered logistic regression. The research encompasses the Bank of England, the Czech National Bank, the National Bank of Poland and the Sveriges Riksbank. They produce conditional or unconditional macroeconomic forecasts. Hence, two paths have been used to examine them. We examine whether the four central banks follow their forecasts to some extent. We have found that the CNB and SR are highly consistent in terms of compatibility of their decisions with the forecasts, timing of decisions, and communication by means of forecasts. The NBP follows its forecast much less consistently, while the BoE ignores it altogether. As some of the results for the BoE and NBP are unambiguous, we remain cautious while interpreting them. This paper contributes to the literature on the empirical evaluation of inflation forecast targeting.

Keywords: inflation forecast targeting, macroeconomic forecasts, central bank decision rules
JEL Classification: E52, E58, C25

1. Introduction

Modern central banks (CB) prepare and publish their own macroeconomic forecasts. Through this they try to shape the expectations of economic agents and make their policy forward-looking. If the deliberations and decisions of the Monetary Policy Committee (MPC) incorporate the message of forecasts, the problem of transmission lags is reduced. Once the central bank uses forecasts, it might implement inflation forecast targeting (IFT), which is postulated to be the best way to conduct forward-looking monetary policy (Svensson, 1997; 2007). A quite common view on monetary policy forward-lookingness (FL) assumes that monetary policy should be guided by output-gap forecasts about one year ahead and inflation forecasts about two years ahead. Current situation is relevant for policy-makers only if it matters for the future output and inflation (Svensson, 2000a).

In this paper, we examine whether the message of a CB's forecasts is indeed incorporated into its decisions. Our purpose is to assess the forecast importance in MPCs' decisions. We want to address the question: do the central banks follow their own macroeconomic forecasts when deciding on interest rates? Following a forecast message means that

* Magdalena Szyszko, Faculty of Finance and Banking, WSB University in Poznan, Poznan, Poland (magdalena.szyszko@wsb.poznan.pl);
Aleksandra Rutkowska, Faculty of Informatics and Electronic Economy, Poznan University of Economics and Business, Poznan, Poland (aleksandra.rutkowska@ue.poznan.pl).

(1) the central bank that produces macroeconomic projections under the constant rate assumption is more likely to raise (lower) the policy rates when the forecast of inflation and output gap diverges upward (downward) from the targets; and (2) the central bank that endogenizes interest rates into macroeconomic forecasts follows its own policy path.

The research covers the Bank of England – BoE (1998–2016), the Czech National Bank – CNB (2002–2016), the National Bank of Poland – NBP (2004–2016), and the Sveriges Riksbank – SR (2006–2016). We selected EU Member States with independent monetary policies conducted under the inflation targeting (IT) regime. These central banks produce and publish macroeconomic forecasts as well as publish data that were utilised in our research. The starting date for each CB is established on the basis of the most recent shift in the forecasting procedures.

All the central banks in question admit to applying forecasting in their monetary policies. They signal different importance of forecasting in their policies. The BoE declaration refers to the content of the entire Inflation Report: "… *it provides a comprehensive and forward-looking framework for discussion among MPC members as an aid to the decision-making*" (BoE, 2016). The CNB openly states that it "*assesses the latest forecast and evaluates the risks of non-fulfilment of this forecast. Based on these considerations the Bank Board then votes on whether and how to change the settings of monetary policy instruments*" (CNB, 2016). Similarly, the SR's declaration is quite unambiguous: the forecast matters a lot. The SR presents a detailed description of the forecast importance in the MPC's deliberations and discloses the decision-making process to the public (Hallsten and Tägtström, 2009). The NBP states that the projection constitutes "*one of the inputs to the Monetary Policy Council's decision-making process concerning the NBP's interest rates*" (NBP, 2015). Forecast is never an ultimate commitment. Therefore, there is some room for evaluation whether the central banks in our sample actually use the forecast in their monetary policy and if they do, then to what extent.

The CBs that we analyse produce forecasts under different interest rate assumptions. The CNB and SR endogenize a repo (or market) rate path (unconditional forecasts), whereas the NBP and BoE[1] apply a constant interest rate assumption (projections, conditional forecasts). Given that the central banks in our sample produce forecasts under two different rate assumptions, we do not aim at making a direct comparison of the results throughout the sample; our goal is to make a comparison of the pairs of countries with the same interest rate assumption. Some degree of comparison of the four CBs is possible in the case of the index-based results, as it offers different solutions to comparing their involvement in IFT.

We rely on a combination of two methods. The first one is the ordered logistic regression. The second one is an index which directly detects the central bank's involvement in inflation forecast targeting. Index-based examination delivers the possibility to cross-check the results of econometric assessment.

1 BoE publishes two forecasts: under market expectations of the interest rate and under the constant interest rate assumption. The latter better serves our purpose as it clearly outlines the decision-making rule. Moreover, the central bank itself should create market interest rates rather than accept the expected level.

This paper contributes to the literature on the implementation of inflation forecast targeting and central banks' forward-looking attitude. The literature on assessment of decisions made in accordance with inflation forecasts is scarce as some methodological constraints occur.

The paper is organised in the following way: Section 2 presents a literature overview; Section 3, methodology and data; Section 4, results and their interpretation. Lastly, we conclude our findings and depict further paths for development of this research.

2. Literature Overview

In this paper, we tackle the issue of forward-lookingness in the MPC's decisions and implementation of inflation forecast targeting. The relevant literature discusses the reasons why forward-lookingness is actually a necessity and analyses IFT as a procedure which complies with FL. The last strand of the literature covers previous research on this subject.

Central banks' forward-lookingness is justified by the modern monetary theory: the expectations of economic agents are a driving factor in the transmission mechanism (Galí, 2008). If so, the central bank's ability to shape expectations facilitates the achievement of an inflation goal (Woodford, 2003) and the stabilisation of output and inflation fluctuations (Rudebusch and Svensson, 1998). Today's expectations might be shaped by revealing forward-looking information (forecasts) and its incorporation into the central bank's deliberations and decisions. If the central bank does so, it implements the procedure that is referred to as inflation forecast targeting.

The second reason for the need to incorporate a certain degree of FL into the MPC's decisions is the existence of monetary policy lags. Monetary policy literature never rejects their existence but there is no consensus as to their length. The most common and general description of them is *long and variable* (Batini and Nelson, 2001). A comprehensive study applying a meta-analysis of the empirical literature on monetary policy lags (sixty-seven published studies) concluded that an average monetary policy lag is 29 months (Havranek and Rusnak, 2013). The central banks usually declare that their interest rate adjustments hit the inflation at the monetary policy horizon, which is between the 4th and 8th quarter after the impulse change. More generally, they announce that the inflation target should be achieved over the medium term. The lag is longer for the price level than for the real sphere variables.

The crucial point from the central bank's perspective is that it should not be *a forecast* but its own forecast based on its analytical model that reflects the transmission mechanism and incorporates monetary policy lags. Central banks which implement inflation targeting produce their own macroeconomic forecasts and publish them. Thus, an inflation (and a real sphere) forecast could be the focal point of discussions of the MPC members. The forecast might become a specific intermediate target and IFT: a rule applying to the monetary policy to simplify its conduct and monitoring of inflation targets (Svensson, 1997; Woodford, 2012). Finally, a forecast makes monetary policies more forward-looking and creates a potential for greater forward-lookingness of economic agents.

The literature presents numerous approaches to the implementation of inflation forecast targeting that is adjusted to the maturity of monetary policy. Several papers by L.E.O. Svensson – a committed advocate of IFT – offer an insight into the IFT evolution. The early papers on IFT recognised forecasts as the intermediate target of monetary policy. The forecast was produced under the constant rate assumption (projection). The rule of thumb motivated the MPC decisions: if the inflation projection in the monetary policy horizon was above (below) the inflation target, the central bank's rates should be raised (lowered). If the central path of inflation projection remained around the inflation target – no change in the interest rates was suggested by the rule (Svensson, 1997). Subsequent papers placed IFT under flexible inflation targeting, where the central bank stabilises the output gap (Svensson, 2002). Endogenization of interest rates and introduction of a specific targeting rule were the next steps in Svensson's research (2003a, 2003b). Finally, he proposed that expert judgements should be incorporated into the forecasting process (2005) and advocated extreme transparency, including the publication of the weights attributed to the inflation and output gap stabilisation (2007).

The IFT procedure is well described in the literature from the theoretical point of view. It is much more difficult to empirically evaluate the MPC's actual involvement in IFT. One strand of literature relevant to its assessment covers a search of the CBs' reaction functions. Most papers discussed herein present theoretical or empirical evaluation of extensions of the canonical Taylor rule (Taylor, 1993). When taking into account the inflation gap and the output gap, these reaction functions refer to lagged or contemporaneous data specifications, or – most commonly – to some forward-looking variation covering expectations or forecasts. Once the forecast is included in the reaction function under analysis, the IFT implementation is verified. Some authors compare alternative specifications of reaction functions from a theoretical (Giannoni and Woodford, 2003), (Machaj, 2016) or empirical point of view (Kotłowski, 2006). Some extensions of the Taylor rule take into consideration additional variables such as exchange rates (Svensson, 2000), foreign interest rates (Arlt and Mangel, 2014) or public debt (Mackiewicz-Łyziak, 2017). They generally confirm the forward-looking attitude of policy makers, while the relevance of other variables differs across the countries and depends on the model's assumptions. The papers presenting the search for MPCs' reaction functions are associated with our paper only if they cover forward-looking specifications with inflation forecasts in inflation gaps. This approach is applied rarely as it could be tested only for CBs that prepare and reveal inflation projections based on the constant interest rate assumption. Its application of endogenous interest rate paths (unconditional forecasts) is questioned in the literature (Arlt and Mangel, 2014).

Brzoza-Brzezina *et al*. (2013) used the inflation projections of the National Bank of Poland, the Swiss National Bank, and the Bank of England to reconstruct the horizons these central banks considered in the process of making their interest rate decisions. They come up with mixed results: the NBP and the SNB proved to be more forward-looking in targeting the inflation gap, whereas the BoE when targeting the output gap. To the best of our knowledge, the attempts made to empirically assess the central banks' involvement in IFT on the basis of ex-post decisions with endogenous interest rates (in this paper,

the CNB and the SR) were of a qualitative or index-based nature (Szyszko, 2017). We refer to the methodology presented there, described in Section 3.

As previously mentioned, the unconditional forecasts used in testing the forward-looking Taylor-type reaction functions are questioned be some (not to mention critics of the Tayor rule itself). Consequently, in this study, our test principally concerns checking the degree of probability to which MPCs that have decided to reveal their policy paths will follow their own forecast. As the policy path itself incorporates the optimum – from the CB's perspective – future inflation gap and output gap, the only piece of information we consider to be decisive in the case of Sweden and the UK is the policy path.

3. Data and Methodology

Several constraining conditions exist when it comes to examining a CB's involvement in IFT. First, the number of inflation-targeting central banks is limited. They produce their macroeconomic forecasts under different rate assumptions which keep changing with time. Moreover, the methods of publishing their macroeconomic forecasts tend to vary. The time series length is limited: even the central banks that have been publishing macroeconomic forecasts for a relatively long time did not reveal the numerical data at the beginning of the publication period. Consequently, we decided to apply two different methods: ordered logistic regression and the index-based measure. Table 1 shows the sample and data sources used in the study.

Table 1 | Sample and data sources

Central bank	BoE	CNB	NBP	SR
Time span	**1998–2016**	**Jul 2002–2016**	**Aug 2004–2016**	**Oct 2006–2016**
Number of forecasts	77	58	42	59
Interest rate assumption	Constant CB rate	Endogenous	Constant CB rate	Endogenous
Source of the forecast	Inflation reports	Inflation reports	Inflation reports	Monetary policy reports and their updates
Decision rationale	Monetary Policy Summary	Minutes	Information from MPC meeting	Press releases

Source: Authors.

After statistical procedures[2], we estimate the ordinal logistic regression model. Consider a variable Y with categorical outcomes γ_j, where $j = 1, 2, ..., k$ and $\boldsymbol{X}$ denotes

2 The analysis of the data starts off with contingency tables, measures of association, and related statistics (Chi-Square test of independence, Somer's D measures of association, symetric measures of association: gamma, Kendall's tau-b or Kendall's tau-c). Due to the length of the paper, we do not present that part of the examination fully.

a p-dimensional vector of covariates. The dependence of Y on $\boldsymbol{X}$ for the proportional odds model in the logit form can be presented as follows:

$$\text{logit } \Pi_j = \log \frac{\Pi_j}{1-\Pi_j} = \log\left(\frac{\Pr\left(Y \le y_j \mid X = x\right)}{\Pr\left(Y > y_j \mid X = x\right)}\right) = \alpha_j + \boldsymbol{x'\beta}, \tag{1}$$

where Π_j is the probability, α_j is the cut-points, unknown parameters satisfying the condition $\alpha_1 \le \alpha_2 \le \ldots \le \alpha_{k-1}$, and $\boldsymbol{\beta} = (\beta_1, \ldots, \beta_p)'$ is the vector of the regression coefficients corresponding to $\boldsymbol{X}$.

Logistic slope coefficients can be interpreted as the effect of a unit of change in the X variable on the predicted logits with the other variables in the model held constant. Relative risk ratios offer easier interpretation of the logit coefficients. They are the exponentiated values of the logit coefficients. Odds ratios in logistic regression can be interpreted in the following way: keeping all the other variables constant, when x_i increases by one unit, it is e^{β_i} times more likely to be in a higher category. In other words, the odds of moving to a higher category in the outcome variable are $(e^{\beta_i} - 1)100\%$.

One of the underlying assumptions of ordinal logistic regression is that the relationship between each pair of outcome groups is the same. In this model, we assume that the effect of each predictor remains the same across each $k - 1$ logits.

$$\log \frac{\Pr\left(Y \le y_j \mid \boldsymbol{X} = \boldsymbol{x_1}\right) / \Pr\left(Y > \boldsymbol{y_j} \mid X = \boldsymbol{x_1}\right)}{\Pr\left(Y \le y_j \mid \boldsymbol{X} = \boldsymbol{x_2}\right) / \Pr\left(Y > \boldsymbol{y_j} \mid X = \boldsymbol{x_2}\right)} = \boldsymbol{\beta}'(\boldsymbol{x}_1 - \boldsymbol{x}_2). \tag{2}$$

The estimation and inference procedure of the study can be presented in following steps:

1. Fitting an ordinal logit model.
2. Testing the parallel lines assumption.
3. Testing the model: goodness-of-fit measures (the usual Pearson and deviance goodness-of-fit measures); overall model test, significance of the coefficients; strength of association (Cox and Snell, Nagelkerke, McFadden measures).
4. If the model fits well, calculation of category probability is performed.

All the calculations were carried out using the SPSS software and the PLUM (Polytomous Universal Model) procedure. The following models were estimated:

1. For Poland and the United Kingdom:
   a. *Dec on IR ~ CPI*[3] *I + output gap I*
   b. *Dec on IR ~ CPI II + output gap I*
   c. *Dec on IR ~ CPI I + output gap II*
   d. *Dec on IR ~ CPI II + output gap II*
2. For Sweden and the Czech Republic: *Dec on IR ~ Policy path*

3 Central path of inflation projection.

Table 2 shows the encoding method of time series for ordered logistic regression.

Table 2 | Data and their coding

Variable	Description
Dec on IR	Interest rates (IR) decision. IR were: –1: lowered, 0: left unchanged, 1: raised.
Central path of inflation	Central path of inflation at the centre of the monetary policy horizon: –2: below the lower boundary of the accepted inflation fluctuation band, –1: below the inflation target, within the band, 0: on the targeted level, 1: above the inflation target, within the band, 2: above the upper boundary of the accepted inflation fluctuation band.
Policy path	Policy path – instant decision suggested by the path. IR should be: –1: lowered, 0: left unchanged, 1: raised.
Output gap (I)	Output gap in the next quarter – direct case. The output gap is: –1: negative, 0: closed, 1: positive.
Output gap (II)	Output gap in the next quarter – indirect case which incorporates not only the relation of current output into its potential level but also the direction of its change. The output gap is: –1: negative, output falls, –0.5: negative, output rises, 0: close to its potential level, 0.5: positive output gap, output decreases, 1: positive output gap, output increases.

Source: Authors.

We decided to use encoded data and the model appropriate for ordered data because numerically expressed time series are not always accessible[4]. In our sample, the NBP discloses only a fan chart with the central path of inflation projections,[5] while the CNB started to publish the policy path numerically in 2008. We use more than one coding approach for the output gap: the second one is more consistent with the transmission of monetary policy as not only does the relation of actual output to its potential value matter but the direction of its change as well.

4 Not revealing the numbers, funcharts are a common practice of central banks. Applying procedures for ordered data, it is possible to enlarge the sample with the use of the same methodology.

5 The NBP publishes a numerically expressed central path of inflation projections for subsequent years in a forecast horizon. In this study, we use quarterly data.

Table 3 | Index-based assessment of the IFT involvement

IFT aspect	Point attribution
Decision alignment to the forecasts	For the **constant interest rate assumption:** the relation of the central path of inflation (CPI) projection to the inflation target at the monetary policy horizon (nearing its midpoint) offers the rule of thumb for decision-making. If the central path is above (below) the inflation target, the central bank rates should be raised (lowered). When the central path remains around the target level, the rates should be left unchanged. **2 points:** the decision is compatible with the rule, **1 point:** the MPC's freedom point (the decision does not follow forecasts in strict terms, but it is not in contradiction to it either): – no change when the CPI misses the target, but remains within the accepted target limit, – a change when the CPI is around the target level. **No points:** the decision is in contradiction with the rule: – no change when the target boundary is missed, – opposite direction change.
	When **policy path** (PP) is published: the MPC should follow its suggestion of immediate decision: **2 points:** the decision is compatible with the rule, **1 point:** the MPC's freedom point: – no change when the PP suggests changes and the CPI is within the accepted fluctuation band, – interest rates change when the PP is constant, but the CPI diverges from the target. **No points:** the decision is in contradiction with the rule: – opposite–direction decision, – change of the interest rates when the policy path suggests no change and the CPI is at the target level.
Decision timing	**1 point** for: – making a decision when the forecast is up to date, – no interest rate change in the period between two forecasting rounds. A special case occurs when the decision is made between the publications of subsequent forecasts: percentage of one point decreases proportionally to the number of the MPC meetings between the forecasts. **No points** for: – decision that is not in line with the forecast (regardless of its timing), – making a decision on the interest rate change at MPC meetings which occur just before the next forecast publication.
Decision rationale	**2 points** when the forecasts are central in the decision rationale. **1 point** if the forecasts are presented in the decision rationale, but they are not at the core of it. No points if the forecast is absent in the decision rationale.

Source: (Szyszko, 2017), version modified by authors.

We also take on two horizons of the central path of inflation (4th quarter – described as *CPI I,* and 6th quarter – described as *CPI II* once the forecast was revealed), which cover the beginning and the central point of the standard transmission horizon,[6] and one for the output gap (1st quarter). The shortest horizon for the output variable is theory-consistent. Our implicit assumption is that there are some sensitivity intervals around the targeted level (for both inflation and output). It means that the central path of inflation at the target level does not necessarily mean that the forecast inflation is precisely at the targeted level. While testing the dependence of the policy path and the actual decision (CNB and SR), we refer to the shortest end of the policy path (the first decision suggested by the path).

The forecast is prepared less frequently than MPC meetings are held. This is why we analyse simultaneously one forecast and the MPC decisions made in the month the forecast was produced and in the following months leading to the next forecast publication.

As the time span covers the low inflation and deflation period, when many central banks operate at the zero lower bound, *Dec on IR* includes – in addition to the interest rate decision – additional monetary policy measures, such as quantitative easing programmes. The announcement of such a programme is treated as a decrease in interest rates, whereas its withdrawal as an increase in interest rates.

The index-based part of the research provides a concise qualitative framework for involvement in IFT. It is a more general assessment tool in comparison to the model-based analysis of IFT implementation. This method captures some aspects that cannot be covered by the ordered logistic regression. The index reflects the rules of central banks' decision-making processes that are part of IFT. Thus, it can be used to check if the rule is being implemented, decision by decision. However, the index is somewhat skewed to the fixed inflation targeting strategy. In the case of conditional forecasts, it assesses whether the central bank targets its inflation projection. In the case of unconditional forecasts, it also gives some priority to inflation as the so-called freedom point refers to the deviation of inflation from the inflation target (see Table 3). Measuring qualitative aspects of monetary policy with the use of a simple index is broadly accepted. It is enough to mention the transparency measures developed by Eijffinger and Geraats (2006).

4. Results and Interpretation

The ordinal regression results[7] are presented in the tables below. Full estimations of the models and model properties are presented in the Appendix. The description of the results starts with a brief presentation of the statistical analysis results, which – as we have already explained – are not presented in details due to the length of the paper.

6 Given that forecasting models return to a steady state in the long run, the relation of the central path of inflation to the target at the end of the transmission horizon (8th quarter) was predominantly close to the targeted level. It would substantially reduce diversification of the encoded data.

7 We estimate and present only one model for the CNB and the SR, whereas there are four models for the NBP and the BoE. As for the latter, we choose to present a model with the best goodness-of-fit.

Contingency tables for the CNB and SR which include observed and expected frequencies (the number of cases that could be expected assuming the marginal distribution of a variable and the assumption that *Decision on IR* and *Policy path* are independent of each other) of the interest rate change (*Dec on IR*) according to the *Policy path* suggestion are different and their differences are statistically significant. Moreover, not only do correlations (between *Dec on IR* and *Policy path*) exist in the two cases, but also they are strong. Somer's D coefficients suggest that the presumption of the decisions by the CNB (SR) on interest rates could improve by 77.30% (75.80%), assuming that the policy path consistent with its macroeconomic forecast is known.

The ordinal regression results are presented in Table 4 for the CNB and in Table 5 for the SR. In these tables, as well as in Table 6, we report cumulative logit, which describes the log-odds of two cumulative probabilities (see Equation 1). These logits are converted into cumulative odds (the exponential of the logits) and cumulative proportions (1/(1-exponential of the logits)). Thus, these statistics describe how likely the *Dec on IR* is to be in category *j* or below versus in a category higher than *j*. Based on the cumulative values, we calculate the probability of the particular category. Our interpretation focuses on this value. If the *Policy path* equals 1 (interest rates, if they are moved consistently with the forecast of inflation and output, should be raised), then *Dec on IR* will be 1 (CB rates are higher or alternative restrictive monetary policy action is taken) with the probability being 73% for the CNB and 82% for the SR. For these central banks, the probability of following the *Policy path* is prevalent in all the remaining cases as well.

Table 4 | Regression results – estimated category probabilities for CNB

		Dec on IR		
		–1	**0**	**1**
***Policy path* = –1**	cumulative logit	–	1.16	26.92
	cumulative odds	–	3.20	4.93E+11
	cumulative proportion	1.00	0.24	0.00
	category probability	0.76	0.24	0.00
***Policy path* = 0**	cumulative logit	–	–3.22	22.54
	cumulative odds	–	0.04	6.16E+09
	cumulative proportion	1.00	0.96	0.00
	category probability	0.04	0.96	0.00
***Policy path* = 1**	cumulative logit	–	–26.74	–0.98
	cumulative odds	–	0.00	0.38
	cumulative proportion	1.00	1.00	0.73
	category probability	0.00	0.27	0.73

Source: Own calculation.

Table 5 | Regression results – estimated category probabilities for SR

		Dec on IR		
		–1	**0**	**1**
***Policy path* = –1**	cumulative logit	–	1.39	22.73
	cumulative odds	–	4.00	7.46E+09
	cumulative proportion	1	0.20	0.00
	category probability	0.80	0.20	0.00
***Policy path* = 0**	cumulative logit	–	–0.51	20.84
	cumulative odds	–	0.60	1.12E+09
	cumulative proportion	1	0.63	0.00
	category probability	0.38	0.62	0.00
***Policy path* = 1**	cumulative logit	–	–22.89	–1.54
	cumulative odds	–	0.00	0.21
	cumulative proportion	1	1.00	0.82
	category probability	0	0.18	0.82

Source: Own calculation.

Both central banks that produce and reveal their unconditional interest rates are heavily involved in IFT. The results of the index-based analysis confirm it (Table 7). The relevant outcome has also confirmed the CBs' own declarations of the IFT implementation. The public may perceive the interest rate paths as credible, at least at their short end. Even if the forecast and the policy path are never a commitment (which our results have confirmed as well), their importance for policy-makers is immense in the case of the Czech Republic and Sweden.

The BoE and the NBP implement IFT in the simplest version, as described in Svensson's earliest publications (1997). It is still IFT, but according to some authors, the fundamental aspect of IFT performed under a full-fledged IT is that the policy interest rate is an endogenous variable derived from the policy reaction function or from the loss function of the central bank (Clinton *et al*., 2017). In the case of the BoE and the NBP, whilst checking with our index whether the CBs implement IFT, we assessed the rule of thumb implementation. Thus, we refer only to the deviation of inflation at the monetary policy horizon from the inflation target. The index-based results in both cases are much worse (which entails reduced consistency in following the inflation projections) in comparison to the cases of the CNB and the SR.

The observed and expected frequencies of interest rate decisions, the central path of inflation projections (in the 4th and 6th quarter), and the output gap (encoded in two

ways) differ significantly for the NBP, whereas for the BoE decisions, they differ only for the central path of inflation projection in the 6th quarter. The associations between the CBs' decisions and inflation projection or the output gap are statistically significant for the NBP but not for the BoE. They are weak to moderate, and stronger for inflation projection than for the output gap.

Table 6 | Regression results – estimated category probabilities for PL

		Dec on IR		
		–1	**0**	**1**
***CPI I* = –2**	cumulative logit	–	0.35	3.21
	cumulative odds	–	1.42	24.76
	cumulative proportion	1.00	0.13	0.04
	category probability	0.87	0.09	0.04
***CPI I* = –1**	cumulative logit	–	–0.43	2.43
	cumulative odds	–	0.65	11.32
	cumulative proportion	1.00	0.61	0.08
	category probability	0.39	0.53	0.08
***CPI I* = 0**	cumulative logit	–	–1.22	1.64
	cumulative odds	–	0.30	5.18
	cumulative proportion	1.00	0.77	0.16
	category probability	0.23	0.84	0.16
***CPI I* =1**	cumulative logit	–	–0.26	0.86
	cumulative odds	–	0.77	2.37
	cumulative proportion	1.00	0.57	0.30
	category probability	0.43	0.27	0.30
***CPI I* =2**	cumulative logit	–	–2.78	0.08
	cumulative odds	–	0.06	1.08
	cumulative proportion	1.00	0.94	0.48
	category probability	0.06	0.46	0.48

Source: Own calculation.

In the ordinal regression for the BoE and the NBP, we test two inflation projection horizons (the beginning and the end of the standard monetary policy horizon) and two ways of output

Prague Economic Papers, 2019, 28(3), 257–275, https://doi.org/10.18267/j.pep.711

gap coding. The most adequate model for Poland includes *CPI I* (central path of projected inflation in the horizon of 4Q) and *Output gap II* (where the output gap is encoded in five categories) as independent variables. However, the output gap estimation is statistically insignificant (see Appendix 3). The conclusions based on this model can be formulated as follows. For a one-unit increase in *CPI I* (*i.e.*, going from the target category: 0 to above the target, but within the target boundary: 1), we expect a 0.783 increase in the ordered log odds of being at a higher level of decision, given that *Output gap II* remains constant. Thus, it can be said that for a one-unit increase in *CPI I*, *i.e.*, going from 0 to 1, the odds of decision = 1 versus the combined 0 and −1 categories are 2.1873 greater. The calculated probabilities are presented in Table 6.

For the BoE decisions, we have failed to find a pattern described by ordered logit regression. The lack of differences in counts for most of the pairs of variables as well as the lack of associations among the BoE decisions and our independent variables suggested such a situation. Our models are insignificant as well. Only one model (with *CPI II* and *Output gap II*) is statistically better than the model with an intercept only at the significance level 0.1, but *p*-values of both coefficients are greater than 0.1 and none of the pseudo R-squares is greater than 8%. Previous research has suggested that the BoE does not focus on future inflation, but it takes into account current or future outputs (Brzoza-Brzezina *et al*., 2013). Neither did we find in this study the other link, but we confirm that the BoE does not implement IFT.

The index-based results, on which we have already commented, are presented in Table 7 (the value of the entire index and the results of the qualitative evaluation of decision compatibility with the forecast). The central banks which prepare unconditional forecasts outperform the other pair in every aspect of the index.

Table 7 | Index-based results

Central bank	BoE	CNB	NBP	SR
IFT involvement	59%	91%	59%	94%
Decision compatibility	56%	91%	65%	86%
Decision timing	86%	94%	63%	100%

Source: Own calculation.

Our main findings from this study are as follows: the policy path consistent with the macroeconomic forecasts of the CNB and the SR is a driving factor behind the MPC decisions. This evidence is derived from the examination of the index-based, statistical, and model-based analyses. The instances of the BoE and NBP cannot be interpreted straightforwardly. The index captures a certain degree of consistency in following inflation projections in decision-making processes, while the statistical analysis of the targeted variables (inflation and output gap) proves lower associations and general insignificance of the variables under the model-

based analysis (even if some cases matter). The index refers rather to strict IT, which means that for the central banks only inflation projections matter, but they cover more comprehensively the application of macroeconomic forecast in communication and decision timing as well. The decision compatibility shown by the BoE, amounting to 56%, was not enough to be captured by the model-based analysis, whereas in the case of NBP, the value of 65% compatibility was sufficient.

The unambiguity of the results for the countries with conditional forecasts might be caused by shortcomings of the sample, *i.e.*, the limited quantity of forecasts (especially for the NBP) and the limited diversification of cases (especially for the BoE). Moreover, once the policy path is produced, it takes into account both the central bank's goals. On the other hand, conditional forecasts analyse the deviations of inflation or the output gap from the targeted level one by one. Once the central bank implements flexible inflation targeting, it is more difficult to reconcile the deviations of inflation and the output gap from their equilibrium levels without an endogenous policy path. Nonetheless, the central banks which publish conditional forecasts produce unconditional forecasts for their internal use. Furthermore, the BoE prepares and publishes projections based on the market interest rates.

When the CB decides to publish unconditional forecasts, it complements its monetary strategy. It is enough to read the MPCs' decision rationale or minutes: they refer to macroeconomic forecasts in Czechia and Sweden. The CNB and the SR outperform the BoE and the NBP in terms of IFT implementation in every respect: compatibility and timing of decisions and their importance in their decision rationale. With the exception of the divergences in experience between the central banks that we cover, the most important factor to explain the difference is of a qualitative nature: the MPC's attitude towards IFT does indeed matter.

Finally, we should underline the central banks' consistency in their communication about the forecast importance: many declarations of the CNB and the SR have been reflected in their actions. The MPCs' involvement in the policy path elaboration surely boosts its applicability. The ownership of the forecasts also matters: the NBP projections are staff-owned: there is no MPC involvement in their elaboration. In contrast to the Polish case, the fan charts included in the BoE Inflation Reports represent the MPC's best collective judgement about the most likely paths of economic variables, as well as the uncertainties surrounding their evolution. Still, this is not enough to ensure consistent forecast following. The MPCs of the CNB (forecasts owned by the central bank) and the SR (forecasts owned by the Bank Board) are also involved in macroeconomic forecasting and policy path elaboration, which in our opinion highly supports their consistency in IFT. Quite ambiguous declarations of the BoE and the NBP about their role in decision making are reflected in the mean index values and poor model-based results. This is also a sign of how central banks' declarations are consistent with their actions. It is acceptable within the framework of IT, which is an information inclusive-strategy that simply finds some additional benefits in making the forecast an intermediate goal or in driving the decision-making factor. However, commitment is never the case.

5. Conclusion

The aim of this paper was to assess the central bank's commitment to IFT. To this end, we analyse compatibility between banks' decisions and their macroeconomic forecasts, timing of their decisions and, additionally, the way a given decision is explained to the public. We compare four central banks producing forecasts under two different interest rate assumptions. The results are as follows: the CNB and the SR are highly IFT-committed. The BoE and the NBP refuse to apply interest rate endogenization in their basic forecast scenarios. Thus, in order to assess their IFT commitment, we examine whether they follow the rule of thumb while steering the interest rates. In the light of the index-based analysis, they are both less committed to the IFT, whereas the statistical and model-based analyses do not produce a conclusive result for Poland and question the BoE's focus on its own inflation projection or output gap.

Our research complements the scant literature intended to assess central banks' involvement in IFT. In this study, we applied an index and an ordered logistic regression. In making the contribution in the form of this paper, we recognise some points that suggest further development of this research. First of all, we can use a different forecast horizon. The research could be repeated for longer horizons as well. Consequently, we could arrive at conclusions on the targeting horizons of the central banks that produce conditional forecasts. Secondly, in the case of the central banks with unconditional forecasts, we could examine their policy path reliability in the longer run. One of the usual critical comments made about numerical publications on the whole policy path is that they quickly become outdated. There is too much uncertainty in the economic environment to provide an accurate forecast of central banks' interest rates to the public (Kahn, 2007). Our research proves the path applicability only at its short end. Other studies prove its uselessness at longer horizons (Goodhart and Bin Lim, 2011).

Appendices

Appendix 1 | Ordinal regression estimation for SR

		Estimate	std. error	Wald	df	*p*-value	95% confidence interval	
							Lower	Upper
Threshold	[Dec on IR = –1]	–22.886	0.365	3,928.387	1	0.000	–23.602	–22.171
	[Dec on IR = 0]	–1.540	0.636	5.863	1	0.015	–2.787	–0.293
Location	[Policy path = –1]	–24.273	0.871	776.916	1	0.000	–25.979	–22.566
	[Policy path = 0]	–22.376	0.000	–	1	–	–22.376	–22.376
	[Policy path = 1]	0	–	–	0	–	–	–

Source: Own calculation.

Appendix 2 | Ordinal regression estimation for CNB

		Estimate	std. error	Wald	df	*p*-value	95% confidence interval	
							Lower	Upper
Threshold	[Dec on IR = –1]	–26.741	1.020	687.565	1	0.000	–28.740	–24.742
	[Dec on IR = 0]	–0.981	0.677	2.099	1	0.147	–2.308	0.346
Location	[Policy path = –1]	–27.904	1.141	597.795	1	0.000	–30.141	–25.667
	[Policy path = 0]	–23.522	0.000	–	1	–	–23.522	–23.522
	[Policy path = 1]	0	–	–	0	–	–	–

Source: Own calculation.

Appendix 3 | Ordinal regression estimation for NBP, independent variables as covariates

		Estimate	std. error	Wald	df	*p*-value	95% sig	
							Lower	Upper
Threshold	[Dec on IR II = –1]	0.349	0.538	0.422	1	0.516	–0.705	1.403
	[Dec on IR II = 0]	3.209	0.800	16.075	1	0.000	1.640	4.778
Location	CPI 1	0.783	0.291	7.212	1	0.007	0.211	1.354
	Output gap II	0.195	0.231	0.709	1	0.400	–0.258	0.648

Source: Own calculation.

Appendix 4 | Ordinal regression estimation for BoE, independent variables as covariates

		Estimate	std. error	Wald	df	*p*-value	95% sig	
							Lower	Upper
Threshold	[Dec on IR. II = –1]	–0.917	0.276	11.02	1	0.001	–1.459	–0.376
	[Dec on IR II = 0]	1.896	0.348	29.71	1	0.000	1.214	2.578
Location	CPI 2	0.366	0.246	2.214	1	0.137	–0.116	0.847
	Output gap II	0.232	0.171	1.840	1	0.175	–0.103	0.566

Source: Own calculation.

Appendix 5 | Model fitting information

CB	Model	–2 log likelihood	Chi-square	df	*p*-value
SR	Intercept only	67.355	–	–	–
	Final	9.064	58.291	2.000	0.000
CNB	Intercept only	74.072	–	–	–
	Final	7.851	66.221	2.000	0.000
NBP	Intercept only	64.075	–	–	–
	Final	51.920	12.155	2.000	0.002
BoE	Intercept only	75.127	–	–	–
	Final	70.213	4.913	2.000	0.086

Source: Own calculation.

Appendix 6 | Goodness-of-fit statistics

CB	Chi-square	Df	*p*-value
SR	0.000	2.000	1.000
	0.000	2.000	1.000
CNB	0.000	2.000	1.000
	0.000	2.000	1.000
NBP	44.383	34.00	0.110
	40.746	34.00	0.198
BoE	38.345	28.00	0.092
	40.466	28.00	0.062

Source: Own calculation.

Appendix 7 | Pseudo R-square

CB	Cox and Snell	Nagelkerke	McFadden
SR	0.628	0.711	0.461
CNB	0.681	0.799	0.599
NBP	0.251	0.288	0.140
BoE	0.061	0.072	0.033

Source: Own calculation.

Appendix 8 | Parallel test line

CB	Model	–2 log likelihood	Chi-square	df	*p*-value
SR	Null hypothesis	9.064	–	–	–
	General	9.064	0.000	2.000	1.000
CNB	Null hypothesis	7.851	–	–	–
	General	7.851	0.000	2.000	1.000
NBP	Null hypothesis	51.920	–	–	–
	General	48.676	3.244	2.000	0.197
BoE	Null hypothesis	70.213	–	–	–
	General	68.946	1.268	2.000	0.531

Source: Own calculation.

References

Arlt, J., Mandel, M. (2014). The Reaction Function of Three Central Banks of Visegrad group. *Prague Economic Papers,* 23(3), 269–289, https://doi.org/10.18267/j.pep.484

Batini, N., Nelson E. (2001). The Lag from Monetary Policy Actions to Inflation: Friedman Revisited. *International Finance,* 4(3), 381–400, https://doi.org/10.1111/1468-2362.00079

Bank of England (2016). *Inflation Report. November.* London: Bank of England.

Brzoza-Brzezina, M., Kotłowski, J., Miśkowiec, A. (2013). How Forward-looking are Central Banks? Some Evidence from Their Forecasts. *Applied Economics Letters,* 20(2), 142–146, https://doi.org/10.1080/13504851.2012.684780

Clinton, K. et al. (2017). *Czech Magic: Implementing Inflation-forecast Targeting at CNB.* IMF. Working Paper No. 17/21, https://doi.org/10.5089/9781475572971.001

Czech National Bank (2016). Inflation Targeting in the Czech Republic. Prague: Czech National Bank. [Retrieved 2017-05-12] Available at: https://www.cnb.cz/en/monetary_policy/inflation_targeting.html

Eijffinger, S. C., Geraats, P. M. (2006). How Transparent are Central Banks? *European Journal of Political Economy,* 22(1), 1–21, http://doi.org/10.1016/j.ejpoleco.2005.09.013

Galí, J. (2003). New Perspectives on Monetary Policy, Inflation, and the Business Cycle, in Dewatripont, M., Hansen, L., Turnovsky, S., eds., *Advances in Economics and Econometrics: Theory and Applications.* Cambridge: Cambridge University Press, pp. 151–197, https://doi.org/10.1017/CBO9780511610264.007

Giannoni, M. P., Woodford, M. (2003). How Forward-looking Optimal Monetary Policy? *Journal of Money, Credit, and Banking,* 35(6), 1425–1469, https://doi.org/10.1353/mcb.2004.0029

Goodhard, Ch. A. E., Bin Lim, W. (2011). Interest Rate Forecast: a Pathology. *International Journal of Central Banking,* 7(2), 135–170.

Hallsten, K., Tägtström, S. (2009). The Decision-making Process – How the Executive Board of the Riksbank Decides on the Repo Rate. *SR Economic Review,* 1, 69–89.

Havranek, T., Rusnak, M. (2013). Monetary Transmission Lag: A Meta-analysis. *International Journal of Central Banking,* 12, 39–76.

Kahn, G. A. (2007). Communicating a Policy Path: the Next Frontier in Central Bank Transparency*? Federal Reserve Bank of Kansas City, Economic Review,* Q1, 15–16.

Kotłowski, J. (2006). Reaction Functions of the Polish Central Bankers – a Logit Approach. *Bank and Credit,* 4, 4–18.

Machaj, M. (2016). Can the Taylor Rule be a Good Guidance for Policy? The Case of 2011-2088 Real Estate Bubble. *Prague Economic Papers,* 4(25), 381–395, https://doi.org/10.18267/j.pep.573

Mackiewicz-Łyziak, J. (2017). Are Central Banks in CEE Concerned about the Burden of Public Debt? *Comparative Economic Research,* 20(1), 35–51, https://doi.org/10.1515/cer-2017-0003

National Bank of Poland (2015). *Inflation Report.* Warsaw: National Bank of Poland.

Rudebusch, G., Svensson, L. E. O. (1998). *Policy Rules for Inflation Targeting.* Stockholm University, Institute for International Economic Studies. Seminar Papers No. 637 [Retrieved 2017-05-12] Available at: http://su.diva-portal.org/smash/get/diva2:327707/FULLTEXT01

Svensson, L. E. O. (1997). Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets. *European Economic Review,* 41(6), 1111–1146, https://doi.org/10.1016/S0014-2921(96)00055-4

_____ (2000a). Forward-looking Monetary Policy, Leading Indicators, and the Riksbank's Inflation Report vs. the ECB's Monthly Bulletin. [Retrieved 2017-05-12] Available at: https://larseosvensson.se/files/papers/ep0090.pdf

_____ (2000b). Open-economy Inflation Targeting. *Journal of International Economics,* 50(1), 155–183, https://doi.org/10.1016/S0022-1996(98)00078-6

_____ (2002). Inflation Targeting: Should it be Modeled as an Instrument Rule or a Targeting Rule? *European Economic Review,* 46(4–5), 771–780, http://doi.org/10.1016/S0014-2921(01)00212-4

_____ (2003a). The Inflation Forecast and Loss Function, in Mizen, P., ed., *Central Banking, Monetary Theory and Practice: Essays in Honour of Charles Goodhart.* Vol. I, Cheltenham: Edward Elgar Publishing, pp. 135–152.

_____ (2003b). What is Wrong with Taylor Rules? Using Judgements in Monetary Policy through Targeting Rules. *Journal of Economic Literature,* 41(2), 426–477, https://doi.org/10.1257/.41.2.426

_____ (2005). Monetary Policy with Judgments: Forecast Targeting. *International Journal of Central Banking,* 1, 1–54.

_____ (2007). Optimal Inflation Targeting: Further Development of Inflation Targeting, in Mishkin, F. S., Schmidt-Hebbel, K., eds., *Monetary Policy under Inflation Targeting.* Santiago: Banco Central de Chile, pp. 187–225.

Szyszko, M. (2017). How the Central Bank Makes Decision on Interest Rates? Comparative Analysis of Forecast Importance. *Equilibrium. Quarterly Journal of Economics and Economic Policy,* 12(2), 281–294, http://doi.org/10.24136/eq.v12i1.15

Taylor, J. B. (1993). Discretion versus Policy Rules in Practice. *Carnegie – Rochester Conference Series on Public Policy,* 39, 195–214, https://doi.org/10.1016/0167-2231(93)90009-l

Woodford, M. (2003). *Interest and Prices. Foundations of Theory of Monetary Policy.* Princeton: Princeton University Press. ISBN 9780691010496.

_____ (2012). Forecast Targeting as a Monetary Policy Strategy: Policy Rules in Practice, in Koeing, E. F. et al., eds., *The Taylor Rule and the Transformation of Monetary Policy.* Stanford: Hoover Institution Press Publication, pp. 185–284.