Do MPC voting records help predicting policy interest rate?*

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Abstract

This paper provides empirical evidence in favor of timely release of MPC voting records, not published in Poland before the next policymaking meeting, but released much later. The study shows that if the voting records were available before the next MPC meeting they would improve the predictability of policy rate decisions. More specifically, the disagreement on policy actions among MPC members is helpful in predicting the next policy change. The paper combines the use of ordered probit model, real-time data and decision-making meetings as a unit of observation. The predictive ability of voting records is robust to variety of specifications; their inclusion increases the proportion of correctly predicted decisions by 11%. The estimated policy rules outperform the market anticipation of policy actions, made one day before each MPC meeting during the 1999 - 2009 period, and correctly predict about 90% of policy decisions.

Keywords: policy interest rate, Monetary Policy Committee, voting records, ordered probit, real-time data

JEL: C25, C53, E52

1 Introduction

> "By making itself more predictable to the markets, the central bank makes market reactions to monetary policy more predictable to itself. And that makes it possible to do a better job of managing the economy."[1]
>
> - Alan S. Blinder, former Vice Chairman of the Board of Governors of the US Federal Reserve System

Many economic decisions rely on inflationary expectations, while inflation predictability depends on the consistency of monetary policy. More transparent and predictable behavior of central bank

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[1] See Blinder (1998)

itself improves the transmission and effectiveness of monetary policy, as many academic economists and central banks' practitioners seem to agree nowadays[2]. Over the past two decades most central banks have radically increased the public communication as well as disclosure of internal information and methodology used in the monetary policy-making[3]. In many countries the monetary policy is currently conducted by a committee, usually called Monetary Policy Committee or Council (MPC). Particularly, the MPCs typically vote for the policy interest rates. However, there is no consensus on whether the voting records from policy-making meetings should be published. For instance, the Bank of England and US Federal Reserve publish them within three weeks after each policy meeting, while European Central Bank does not publish them at all.

The voting records are available also in Czech Republic, Hungary, Japan, Korea, Poland, and Sweden. However, the studies of monetary policy conduct usually do not take into account the information containing in the available voting records. The literature is routinely focused on the final policy decisions, made in a majority vote, and thus closes the eyes to the information containing in the minority views. As Gerlach-Kristen (2004) showed the voting records of the MPC of the Bank of England are informative about future policy rate changes: minorities' views on the appropriate level of policy rate help forecast the next MPC decision. To promote the transparency the minutes of policy meetings of the MPC of the Bank of England are published monthly, two weeks after the date of each policy decision, and contain the interest rates favoured by all MPC members (including the dissenting ones). In contrast, the MPC of the National Bank of Poland (NBP) does not publish the voting records in its monthly press releases; instead, they are published in the Inflation Reports (recently, three times per year). Therefore, unlike in the UK, they become available for public only with up to five-month delay after the date of policy decision.

This paper raises the following empirical questions. Could publication of MPC voting records within a month after each policy meeting improve predictability of the next policy rate decision of the central bank of Poland? What can be gained by taking into account the disagreement among MPC members while estimating policy rules? The paper shows that the policy decisions of the NBP during 1998-2009 period are rather predictable by using real-time data and appropriate econometric technique - ordered probit model with policy-making meetings as a unit of observation. Taking into account the disagreement among policymakers can, however, significantly improve the predictability of policy decisions and even surpass the market anticipations made one day prior each decision-making meeting. The policy rules, augmented by voting data, explain correctly about 90% of monthly policy actions. As a separate contribution the paper updates a novel Polish real-time data set, compiled in Sirchenko (2007), incorporating the original time series, truly available to policymakers at each policy-setting meeting during the 1998-2009 period. To the best of my knowledge, such data set has never been used in modeling Polish monetary policy and has proved to be fruitful.

The NBP has followed the direct inflation targeting (DIT) strategy[4] with floating exchange rate regime[5] since 1998, and the short-term interest rates may be undoubtedly treated as a principal

[2] See, e.g., Bernanke (2007), Blinder (1998, 2005), Carpenter (2004), Faust and Svensson (2001), Geraats (2001, 2002), Ingves (2007), Issing (2005), Kennedy (2008), Kohn (2008), Poole (2003, 2005), Thornton (2003).

[3] See, e.g., Eijffinger and Geraats (2006) on the transparency of nine major central banks and Łyziak et al. (2006) on the transparency of Polish monetary policy.

[4] The DIT was implicitly adopted as a primary monetary policy strategy in January 1998. The DIT assumes the direct target for official consumer price index and lack of indirect targets such as the money supply or exchange rate. In September 1998 the DIT was officially declared by the MPC in the document "Medium-Term Strategy of Monetary Policy (1999 - 2003)".

[5] Though zloty started floating officially in April 2000, actually, the NBP suspended foreign exchange interventions

instrument and single measure of Polish monetary policy during the entire sample period[6]. Because the policy rates have been always set administratively and have never been the outcome of market interaction of supply and demand, it makes them of special interest for econometric modeling. Such modelling can help market participants to make more efficient decisions by minimizing the uncertainty about future policy actions and, as a result, improve the efficacy of policy: "If practitioners in financial markets gain a better understanding of how policy is likely to respond to incoming information, asset prices and bond yields will tend to respond to economic data in ways that further the central bank's policy objectives" (Bernanke, 2007).

Only a few papers on Polish monetary policy reaction functions apply the discrete-choice approach to address the discreteness of policy rate and utilize the voting records of policy meetings. Kotłowski (2006) estimates triple-choice ordered logit, modeling the direction of change in the restrictiveness of monetary policy proposed by each MPC member. The restrictiveness is measured by the proposed change of policy bias and/or change to the reference rate. Unfortunately, the sample includes only 18 monthly observations for the period 2004/02–2005/07, not enough for a reliable likelihood estimation. Vivyan (2010) uses ordered logit model with member-specific intercept and MPC voting data to compare the monetary policy preferences of MPC members appointed by different parties.

The rest of the paper is structured as follows. Next section describes the data, institutional background and modelling framework. Section 3 provides econometric analysis of the discrete changes to the policy rate using ordered probit approach, real-time data, policy-making MPC meetings as a unit of observation, and voting records of MPC meetings. Section 4 concludes.

2 Data and modelling framework

2.1 Discreteness of policy rate

The reference rate of the NBP[7], introduced in January 1998, sets the path of monetary policy and "determines the minimum yield obtainable on main open market operations, influencing, at the same time, the level of interbank deposit rates for comparable maturities" (NBP, 2005). The dependent variable in this study is a change (including non-zero one) to the reference rate made by the MPC at a decision-making meeting. As Figure 1 demonstrates the NBP has always altered the levels of policy rate in discrete adjustments – the multiples of 25 basis points (a quarter of one percent). Table 1 shows the frequency distribution of reference rate adjustments for the period 1998/02 - 2009/12: all 143 historical rate changes took only twelve values, between -250 and 250 basis points. The reference rate adjustments are distributed heterogeneously: 120 out of 143 changes fall into 4 out of 12 observed discrete values. There are only three or less observations for six values (categories) of dependent variable. It is not sufficient for a reliable maximum likelihood estimation. A usual approach under such circumstances is to combine some adjacent categories with small number of observations. I merge all observed changes into four categories: "large cut (-0.50% or more)", "small

already in mid-1998, de facto entering the floating exchange rate regime (Pruski and Szpunar, 2005).

[6] See Sirchenko (2007) and references therein for more detailed background of monetary policy in Poland.

[7] The rate on 28-day (from 1998 to 2003), 14-day (from 2003 to 2005), and 7-day (since 2005 to present) NBP's money market bills.

cut (-0.25%)", "no change" and "hike" with 25, 15, 87 and 16 observations, respectively. Table 1 presents the frequency distribution of the consolidated changes to the rate. The only consequence of such consolidation is the loss of efficiency – adding (or deleting) another cutpoint does *not* affect the structural latent model (see equations (1) and (2) in section 2.2). This quadruple classification is definitely able to represent the essence of the NBP operating policy and quite closely corresponds to the most recent historical policy rate changes: since February 2002 only five (out of 95) observations are merged with an adjacent category.

2.2 Ordered probit model

To address the discreteness of dependent variable the paper employs an ordered probit approach, which forms a probabilistic forecast of discrete adjustments to the policy rate as a nonlinear function of explanatory variables. This approach assumes an underlying level of the reference rate R_t^* that would have been observed had the NBP been willing to make the continuous (rather than discrete) changes to the rate. At every policy-setting meeting t the NBP determines the change $\Delta R_t^* = R_t^* - R_{t-1}^*$ in this latent rate according to the following formula:

$$\Delta R_t^* = X_t\beta + \varepsilon_t, \tag{1}$$

where $\varepsilon_t \sim$ *Normal iid* $(0, \sigma^2)$ and X_t is a matrix that may incorporate any data relevant for the policymakers and available at date t. Matrix X_t may include the variables in any form (levels, first and second differences) and at any original data frequency.

Although ΔR_t^* is unobserved, the NBP announces the official (i.e. observed) adjustments to the reference rate ΔR_t according to the following rule:

$$\Delta R_t = \begin{cases} \text{"large cut"} & \text{if} \quad \Delta R_t^* \le \gamma_1 \\ \text{"small cut"} & \text{if} \quad \gamma_1 < \Delta R_t^* \le \gamma_2 \\ \text{"no change"} & \text{if} \quad \gamma_2 < \Delta R_t^* \le \gamma_3 \\ \text{"hike"} & \text{if} \quad \gamma_3 < \Delta R_t^* \end{cases}, \tag{2}$$

where $-\infty < \gamma_1 < \gamma_2 < \gamma_3 < \infty$ are unknown thresholds to be estimated.

Assuming Gaussian cumulative distribution function Φ of ε_t, it follows that the probabilities of observing each possible outcome of ΔR_t are

$$\Pr(\Delta R_t|X_t) = \begin{cases} \Pr(\Delta R_t = \text{"large cut"}|X_t) & = \Phi(\gamma_1 - X_t\beta) \\ \Pr(\Delta R_t = \text{"small cut"}|X_t) & = \Phi(\gamma_2 - X_t\beta) - \Phi(\gamma_1 - X_t\beta) \\ \Pr(\Delta R_t = \text{"no change"}|X_t) & = \Phi(\gamma_3 - X_t\beta) - \Phi(\gamma_2 - X_t\beta) \\ \Pr(\Delta R_t = \text{"hike"}|X_t) & = 1 - \Phi(\gamma_3 - X_t\beta) \end{cases} \tag{3}$$

The estimates of β and γ can be obtained by making identifying assumptions (typically, that variance $\sigma^2 = 1$ and the intercept $\beta_0 = 0$) and maximizing the logarithm of likelihood function L with respect to the vector of parameters $\theta = (\gamma, \beta)$:

$$\ln L(\theta) = \sum_{t=1}^{T}\sum_{i=1}^{4} I_{ti} \ln[\Pr(\Delta R_t = D_i|X_t)], \tag{4}$$

where T is the sample size, (D_1, D_2, D_3, D_4) = ("large cut", "small cut", "no change", "hike"), and I_{ti} is an indicator function such that $I_{ti} = 1$ iff $\Delta R_t = D_i$ and 0 otherwise.

2.3 Sample construction

The paper departs from a common practice of employing the quarterly or monthly data averages and uses instead more adequate sample construction. The sample observations are the dates of all monthly policy-rate-setting MPC meetings. The dependent variable is a reference rate change made at each meeting. The data on the right-hand-side variables is taken as it was observed one day before the date of making policy decision, so it consists of already predetermined variables, which are independent of the rate setting at that MPC meeting. The raw data is used in all types of original frequency: daily, monthly and quarterly.

The above data construction avoids the simultaneity problem, which can occur in modeling the systematic responses of policy rates' averages to economic variables' averages for a given month or quarter due to possible interactions between the policy rate and the other variables that can happen during a period of aggregation. Furthermore, this sample design mimics carefully the timing of policy decisions and availability of statistical data, and hence carefully simulates the actual policy-action-generating process.

The latest versions of data commonly used in the empirical literature may differ from the real-time ones because of the revisions. To avoid the distortion of information the study uses the novel real-time data set, compiled and described in Sirchenko (2007) and updated up to the end of 2009. This data set contains the historical time series truly available to the policymakers and public at each policy-decision-making MPC meeting during the period 1998-2009.

2.4 Policy decisions and voting records

The Polish MPC, established in February 1998, consists of the Chair (the President of the NBP), appointed by the President of Poland, and nine other members, appointed in equal proportions by the President of Poland, the Sejm (lower house) and the Senate (upper house) of the Parliament. Members of the Council are appointed for a non-renewable term of six years. The first term of office of the MPC lasted from February 1998 through January 2004[8]. The second term of office of the MPC lasted from February 2004 through January 2010. Since the first MPC Chair had resigned three years earlier in December 2003, the Chair since then has been appointed with a three-year lag with respect to the other members. This paper uses sample period starting from the first MPC meeting in February 1998 and ending in December 2009, almost fully covering the appointment durations of first two Councils. I analyze separately the two sub-samples, first one from 1998/02 to 2004/01 and second one from 2004/02 to 2009/12, matching the first and second terms of the MPC.

The interest rate decisions are made monthly during MPC meetings in the second half of each month by majority vote[9]. Each MPC member can express his preferred policy rate and make a motion to be voted on. Finally, the Chair selects a proposal and members vote on it. Typically, the

[8] Actually, one MPC member was replaced already before the policy meeting in January 2004, and another one was substituted even earlier in 2003 due to the death.

[9] "The MPC shall rule in the form of resolutions adopted by majority vote, in the presence of at least five members, including the Chairperson. In the event of a tied vote, the Chairperson of the MPC shall have a casting vote" (NBP,1997)

first voted proposal commands a majority and then the other proposals are not voted; otherwise, the members vote on the alternative one. The voting of MPC members on Council resolutions have been published first time in May 2001 in the "Inflation Report 2000". Since then until 2007 they have been published quarterly, and from 2008 three times per year in the NBP Inflation Reports. The voting records for 1998-1999 period, to the best of my knowledge, have never been published in the Inflation Reports and have been obtained by author directly from the NBP.

The available voting records, unfortunately, do not provide complete information on the individual policy rate preferences. They contain the description of all proposals submitted for voting and the list of members who voted 'yes' and 'no' at each voting round. The preferred interest rate of a member who voted against the winning proposal is *not* generally recorded. Moreover, the NBP does not disclose such information on request. Therefore, it is not always possible to infer with certainty the favoured interest rate of those members who disagreed with majority. In case of such uncertainty I assumed that the dissenting members favoured the status quo, i.e. no change to the rate, if no alternative proposition was submitted. In case when more than one proposal was put to vote on a meeting and a member voted for different motions I used a proposition that the member supported first. For instance, if a member voted 'yes' for a defeated motion to cut the rate by 0.50% and then also voted 'yes' for a motion to cut the rate by 0.25%, I record the member's preferred change to the rate at this meeting as 0.50% cut, treating his support for 0.25% cut as a compromise decision.

Of course, incomplete voting data required some subjectivity in recovering the policy preferences of dissenting members. However, the above assumptions seem to be quite realistic. The most significant measurement error could potentially arise if a dissenting member, who voted against a winning proposal, say, to cut the rate by 0.50%, was actually in favor of 0.25% cut or perhaps even 0.25% hike (rather than status quo as I assume in such a case) but did not submit his proposal because during the discussion he had realized that his proposal would not receive the majority support. I hope this situation did not happen often. There were actually 19 meetings when MPC voted for a proposal to change the rate but it was defeated and 23 meetings when two proposals were put to vote because the first voted one was defeated. In fact, the voting records do sometimes contain the proposals that were submitted but not put to vote, because another proposal had already received majority. Another possible minor source of error is two meetings when the motion to lower the interest rate by 0.75 percentage points was passed first, therefore the submitted motions to lower the rate by 0.50 percentage points (in December 2008 and January 2009) and to lower the rate by 0.25 percentage points (in January 2009) were not put to voting. The voting records do not indicate who made these proposals that were not voted. In these two cases I assumed that no dissenting member was in favor of status quo[10].

2.5 Measuring disagreement among MPC members

The dissenting members have often proposed the alternative policy decisions. How high was the level of disagreement among MPC members in the interest rate setting? In 143 meetings between February 1998 and December 2009 the policy rate was set unanimously only in 80 of them, mostly (68 times) when no change to the rate was made. I measure the degree of disagreement among MPC

[10] Specifically, I assumed that on the meeting in December 2008 all dissenting members were in favor of 0.50% cut, while on the meeting in January 2009 one dissenting member (Wojtyna) was in favor of 0.50% cut and the other two dissenting members (Filar and Wasilewska-Trenkner) were in favor of 0.25% cut.

members by variable $dissent_t$ calculated, following Gerlach-Kristen (2004), as difference between the average of the changes proposed by the individual MPC members and officially announced change to the reference rate at meeting t. Figures 2 plots such differences for each MPC meeting in 1998-2009 period. According to the figure, *dissent* ranged from -80 to 75 basis points. Table 2 reports average and maximum absolute values of *dissent* separately for 1998/02-2004/01 and 2004/02-2009/12 periods as well as separately for decisions to cut, leave unchanged or hike the policy rate. The degree of disagreement in absolute terms was on average higher for the first Council than for the second one (9.7 versus 3.8 basis points, respectively). Interestingly, the decisions to cut the rate caused on average much stronger disagreement than decisions to hike for both Councils (17.7 versus 5.2, and 7.1 versus 4.3 basis points for the first and second Councils, respectively). The decisions to leave the rate unchanged were accompanied on average by lower degree of disagreement (4.6 and 2.8 basis points for the first and second Councils, respectively) than decisions to change the rate for both Councils.

3 Predicting policy rate changes with MPC voting records

> "What the market needs to know is the policy response function by which the central bank acts in a consistent way over time"
>
> - W. Poole, then-President of the Federal Reserve Bank of St. Louis (Poole, 2003)

In this section I present the econometric evidence on whether the individual voting records of the MPC meetings can improve the prediction of next policy rate move compared to when only the aggregate decision is known. I first estimate the monetary policy reaction functions for both Councils using ordered probit model and find highly systematic response patterns between the interest rate decisions of the NBP and incoming macroeconomic and financial data, available for both policymakers and private public in the real-time setting. Then I show that the voting records of the last MPC meeting, which are not available in Poland before the next meeting (and even much later), are actually highly informative about the next policy decision. Moreover, this finding is robust to variation in the specification of estimated reaction functions. Finally, I compare the prediction of estimated empirical models with market anticipation made one day before each policy meeting. All data used in the empirical estimations were available to market participants except the MPC voting records.

It is worth to mention that correlation between lagged measure of disagreement $dissent_{t-1}$ and current change to the rate ΔR_t is itself very low: Pearson correlation coefficients are 0.13 and -0.03 for the first and second sub-periods, respectively. Indeed, the lagged dissenters' views $dissent_{t-1}$ demonstrate no predictive power for ΔR_t as a single explanatory variable in the ordered probit model for both sub-periods[11].

First, I estimate three standard specifications of monetary policy reaction functions with and without lagged dissenters' impact: (i) pure interest rate smoothing model with two lagged policy rate changes[12]; (ii) Taylor-like rule with interest rate smoothing and (iii) forward-looking Taylor-like

[11] LRs are 2.62 and 0.17, and P-values of the coefficient on $dissent_{t-1}$ are 0.11 and 0.68 for the first and second sub-periods, respectively.

[12] Two lags of dependent variable were chosen among up to twelve lags according to Schwartz criterion for both sub-periods.

rule with interest rate smoothing. The ordered probit estimations[13] are reported in Tables 3, 4 and 5, respectively. In the above specifications the variable $\Delta Inflation$ is month-to-month change in the deviation of CPI from the inflation target; $\Delta Output$ is annualized quarter-to-quarter change in the index of real GDP; $\Delta Exp\_Inflation$ is month-to-month change in the deviation of expected rate of CPI gathered by Ipsos survey of individual consumers from the inflation target; ΔExp_Output is change since the previous release in the annual rate of GDP central projection by NBP over next eight quarters. The fit of all three specifications is definitely better for the second sub-period, where all coefficients are significant at least 5% level (with the only exception of 10% for the second lag of rate change in the forward-looking Taylor rule). In both variations of Taylor rule for the first sub-period the coefficient of $\Delta Output$ and $\Delta Exp\_Inflation$ are strongly insignificant[14].

Adding the impact of dissenters' votes significantly improves all models' ability to explain policy decisions for both sub-periods: the coefficients on $Dissent_{t-1}$ are all significant at 1% level, all pseudo R^2 measures (adjusted Estrella R^2, McFadden's LRI, McKelvey-Zavoina R^2 and proportion of correctly predicted outcomes) are far higher[15]. The best models for the first (second) sub-periods are augmented backward-looking (forward-looking) Taylor rules, which explain correctly about 70% of policy actions and have McKelvey-Zavoina R^2 of 0.56 (0.72).

Tables 6 and 7 report the favoured Empirical Models 1 and 2 for the 1999/02-2004/01[16] and 2004/02-2009/12 sub-periods, respectively. The specification of Empirical Model 1 includes: I_Exp_Inf-T - an indicator variable that is equal to 1 if deviation of CPI forecast by Reuters survey of banking analysts over next 11 months from the inflation target is positive, and 0 otherwise; $\Delta Core\_CPIxac$ - month-to-month change in the core CPI less administratively controlled prices; $\Delta Cons\_Expenditure$ - change since the last MPC meeting in the index of final consumption expenditure of households; $WIBOR6M_t - R_{t-1}$ - spread between 6-month Warsaw interbank offer rate and reference rate set at previous MPC meeting; $\Delta WIBOR1Y$ - change over 365 days in the 30-day average of one-year Warsaw interbank offer rate.

Inclusion of $Dissent$, which coefficient is significant at 1% level, increases log likelihood from -30.56 to -19.90, McKelvey-Zavoina R^2 from 0.91 to 0.97 and proportion of correctly predicted outcomes from 0.70 to 0.87.

The specification of Empirical Model 2 includes: $\Delta Core\_CPItri$ - month-to-month change in the core CPI, 15% trimmed mean; $\Delta Exp\_Inflation$ - month-to-month change in the deviation of expected rate of CPI gathered by Ipsos survey of individual consumers from the inflation target; $\Delta Output$ - change since last MPC meeting in the index of domestic demand; ΔExp_Output - change since the previous release in the annual rate of GDP central projection by NBP over next eight quarters; $\Delta WIBOR1M$ - change since the next day after last MPC meeting in the 1-month Warsaw Interbank offer rate; $WIBOR1Y_t - R_{t-1}$ - spread between 1-year Warsaw interbank offer rate and reference rate set at previous MPC meeting; $Econ\_situation$ - measure of general economic situation

[13] All ordered probit estimations in the paper are performed using Huber(1967)/White(1980) robust standard errors.

[14] Due to lack of available data for ΔExp_Output in the first sub-period the $\Delta Output$ is empoyed in the forward-looking Taylor rule specification.

[15] With the only exception for the count R^2 (proportion of correctly predicted outcomes) in the case of forward-looking Taylor rule for the second sub-period. It is worth to mention, however, that the ML estimation is not optimized with respect to this measure of fit.

[16] The estimated reaction functions become more regular if the first twelve MPC meetings, from February 1998 through January 1999, are omitted from the sample. The year of 1998 was a period of gradual transition to a new framework of DIT (an "interim" year), additionally affected by Russian crisis in August – see Polansky (2004) and Sirchenko (2007) for more information.

from Business Tendency Survey (BTS) in industry gathered by GUS (Central Statistical Office); $\Delta Exp\_Econ\_situation$ - month-to-month change in the measure of expected general economic situation from BTS in industry.

Inclusion of *Dissent*, which coefficient is significant at 1% level, increases log likelihood from -15.17 to -10.53, McKelvey-Zavoina R^2 from 0.98 to 0.99 and proportion of correctly predicted outcomes from 0.87 to 0.93.

Figure 3 reports the correlograms of generalized residuals[17] from Empirical Models 1 and 2 without *Dissent* (top row) and with *Dissent* (lower row): the null of no serial correlation among residuals up to the twelfth order is overwhelmingly accepted at least at 13% level without *Dissent* for both models. In the specification with *Dissent* the null of no serial correlation is overwhelmingly accepted at least at 5% and almost 1% level for Models 1 and 2, respectively. Figures 4 and 5 show the actual and predicted changes to the policy rate together with the predicted likelihood of observed changes for both models. The Models 1 and 2 do not predict correctly only 8 (out of 60) and 5 (out of 71) policy actions, respectively, always anticipating in these cases the adjacent rate change and assigning to the observed changes probabilities between 0.10 and 0.39.

In a next step, I compare the model-implied predictions with market anticipation of next policy move made one day before each policy MPC meeting. Bank analysts from the Reuters survey[18] have foreseen 83% and 87% of next policy actions with the average likelihood of observed outcomes of 0.77 and 0.82, respectively (see Table 8). However, the predictive power of market anticipation is clearly inferior comparing to the estimated empirical models 1 and 2: though the model-implied forecasts are not optimized with respect to percentage of correct predictions, they predict 87% and 93% of next policy decisions with the average likelihood of observed outcomes 0.80 and 0.90, respectively for the first and second sub-periods. Even one day before an MPC meeting the market anticipated the tomorrow policy decision worse than the estimated models with MPC voting data (not available to the bank analysts at the dates of forecasting).

4 Conclusions

The voting records of monetary policy making meetings are not published in Poland before the next monthly meeting of the MPC, but are released later. This paper shows that if the MPC voting records were available to public before the next policy meeting they could improve the predictability of policy decisions. More specifically, the disagreement on policy actions among MPC members are helpful in predicting next policy decision: if dissenters prefer higher reference rate, the MPC is more likely to hike the rate than cut it. This is despite the fact that correlation between policy rate changes and lagged difference between average proposed and announced changes to the rate are quite low (about 0.13). However, in the context of carefully estimated policy rules the dissenters' impact becomes highly informative.

The paper employs a modeling framework (well suited for many central banks) that avoids some

[17] The generalized residuals are defined to be uncorrelated with the explanatory variables of the model – see Chesher and Irish (1987), and Gourieroux et al. (1987) for details.

[18] Reuters has conducted its survey on a monthly basis since 1994. About 30 commercial banks' analysts participate in the survey. Respondents predict several economic and financial variables. These forecasts are widely cited in Poland including the NBP Inflation Reports and MPC press releases. Since 1999 the bank analysts have also predicted the NBP policy rate.

common distortions of policy-action-generating process by combining the use of discrete regression method - ordered probit model, real-time data and decision-making meetings as a unit of observation. The strong predictive power of voting data in employed modeling framework is robust to variety of specifications, including backward- and forward-looking Taylor-like rules augmented by lagged interest rate changes and money market interest rates. The estimated models outperform the market anticipation of policy actions, made one day before each MPC meeting during 1999-2009 period, and correctly predict 90% of policy decisions with 86% average predicted probability of observed decisions. Including voting data improves the proportion of correctly predicted decisions by 11% and average predicted probability of actual actions by 7%.

The above findings are based on the information about desired policy action of all MPC members, but do not require knowledge of MPC members' names attached to each individual policy preference. The empirical evidence presented in the paper suggests that it might be beneficiary for the National Bank of Poland to improve its transparency and policy predictability by publishing the MPC voting records in its monthly press releases as is a common practice in the USA and UK.

References

[1] Bernanke, Ben S. (2007), "Federal Reserve communications", Speech at the Cato Institute 25th Annual Monetary Conference, Washington DC, November 14.

[2] Blinder, Alan S. (1998), "Central banking in theory and practice: The 1996 Robbins lectures", MIT Press, Cambridge, MA.

[3] Blinder, Alan S. and Ricardo Reis (2005), "Understanding the Greenspan standard", CEPS working paper No. 114, presented at the Federal Reserve Bank of Kansas City Symposium, "The Greenspan era: Lessons for the future", August 25-27.

[4] Carpenter, Seth B. (2004), "Transparency and monetary policy: What does the academic literature tell policymakers?", Finance and Economics Discussion Series Paper No. 2004-35, US Federal Reserve Board, April.

[5] Chesher, A., and M. Irish (1987), "Residual analysis in the grouped data and censored normal linear model," *Journal of Econometrics*, 34, pp. 33-62.

[6] Eijffinger, S., Geraats, P. (2006), "How transparent are central banks?", *European Journal of Political Economy*, 22, pp. 1–21.

[7] Faust, Jon W. and Lars E.O. Svensson (2001), "Credibility and transparency: Monetary policy with unobservable goals," *International Economic Review* 42(2), May, pp. 369-397.

[8] Geraats, Petra M. (2001), "Why adopt transparency? The publication of central bank forecasts," European Central Bank Working Paper No. 41, January.

[9] Geraats, Petra M. (2002), "Central bank transparency", *Economic Journal* 112, pp. 532–556.

[10] Gerlach-Kristen, Petra (2004), "Is the MPC's voting record informative about future UK monetary policy?", *Scandinavian Journal of Economics*, 106(2), pp. 299-313.

[11] Gourieroux, C., A. Monfort, E. Renault, and A. Trognon (1987), "Generalized residuals," *Journal of Econometrics* 34, pp. 5-32

[12] Huber, P. J. (1967), "The behavior of maximum likelihood estimates under non-standard conditions", Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability 1, pp. 221–233.

[13] Ingves, Stefan (2007), "Monetary policy, openness and financial markets", BIS Review 106, September.

[14] Issing, Otmar (2005), "Communication, transparency, accountability: Monetary policy in the twenty-first century", Federal Reserve Bank of St. Louis *Review* 87(2, Part 1), March/April, pp. 65-83.

[15] Kennedy, Sheryl (2008), "Transparency – the more, the better?", Remarks to l'Association des femmes en finance du Quebec, Montreal, January 8.

[16] Kotłowski, Jacek (2006), "Reaction functions of the Polish central bankers – a logit approach", *Bank i Kredit* (in Polish), April, pp. 3-18.

[17] Łyziak, Tomasz, Joanna Mackiewicz, and Ewa Stanisławska (2006), "Central bank transparency and credibility: The case of Poland, 1998–2004", *European Journal of Political Economy.*

[18] NBP (1997), The Act on the National Bank of Poland of August 29, 1997.

[19] NBP (2005), "Monetary policy guidelines for the year 2006", National Bank of Poland, Monetary Policy Council, September.

[20] Poole, William (2003), "Fed transparency: How, not whether", Federal Reserve Bank of St. Louis *Review*, November/December, pp. 1-8.

[21] Poole, William (2005), "FOMC transparency", Federal Reserve Bank of St. Louis *Review* 87(1), January/February, pp. 1-9.

[22] Pruski, Jerzy and Piotr Szpunar (2005), "Exchange rate policy and foreign exchange interventions in Poland", BIS Paper No. 24, May, pp. 255-264.

[23] Sirchenko, Andrei (2007), "Modelling monetary policy in real time: An ordered probit approach for Poland", EERC Working Paper No. 08-07, November.

[24] Thornton, Daniel (2003), "Monetary policy transparency: transparent about what?", *Manchester School* 71(5), pp. 478-497.

[25] Vivyan, Nick (2010), "Testing for partizan behavior in independent central banks: An analysis of voting in the National Bank of Poland", London School of Economics and Political Science, Working Paper, January.

[26] White, H. (1980), "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity", *Econometrica* 48, pp. 817–830.

Table 1. Frequency distribution of changes to the NBP reference rate

	Historical changes to reference rate, percentage points												
Sample	-2.50	-1.50	-1.00	-0.75	-0.50	-0.25	0.00	0.25	0.50	1.00	1.50	2.50	All
1998/02-2004/01	2	6	6		6	7	40		1	2	1	1	72
1999/02-2004/01		4	3		6	7	36			2	1	1	60
2004/02-2009/12				2	3	8	47	9	2				71
1998/02-2009/12	2	10	9	2	15	22	123	9	3	4	2	2	143

	Consolidated categories of reference rate changes				
	Large cut	Small cut	No change	Hike	All
1998/02-2004/01	20	7	40	5	72
1999/02-2004/01	13	7	36	4	60
2004/02-2009/12	5	8	47	11	71
1998/02-2009/12	25	15	87	16	143

Table 2. Disagreement on policy decisions among MPC members

Policy decision	Average (maximum) absolute disagreement, basis points	
	1998/02 - 2004/01	2004/02 - 2009/12
cut	17.7 (75.0)	7.1 (12.5)
no change	4.5 (80.0)	2.9 (12.5)
hike	5.2 (15.0)	4.3 (10.0)
All	9.5 (80.0)	3.9 (12.5)

Table 3. Do dissenting votes help predicting policy decisions?

Pure interest rate smoothing model

Sample	1998/02 - 2004/01			2004/02 - 2009/12		
Parameter	Coeff.	Error	Prob.	Coeff.	Error	Prob.
ΔR_{t-1}	2.31	0.71	0.00	3.10	0.81	0.00
ΔR_{t-2}	1.50	0.63	0.02	1.45	0.68	0.03
$Dissent_{t-1}$	3.05	0.91	0.00	8.53	3.22	0.01
γ_1	-1.19	0.24	0.00	-1.72	0.29	0.00
γ_2	-0.84	0.22	0.00	-0.95	0.22	0.00
γ_3	1.37	0.25	0.00	1.73	0.29	0.00
Goodness-of-fit measures with (without) $Dissent_{t-1}$						
Log Likelihood	-67.51 (-74.02)			-54.44 (-58.19)		
AIC	147.02 (158.04)			120.88 (126.37)		
Adjusted Estrella	0.14 (-0.01)			0.27 (0.2)		
McFadden's LRI	0.14 (0.06)			0.23 (0.18)		
McKelvey-Zavoina	0.35 (0.16)			0.46 (0.37)		
Correctly predicted	0.61 (0.49)			0.7 (0.69)		

Table 4. Do dissenting votes help predicting policy decisions?

Taylor rule with interest rate smoothing

Sample	1998/02 - 2004/01			2004/02 - 2009/12		
Parameter	Coeff.	Error	Prob.	Coeff.	Error	Prob.
ΔR_{t-1}	2.11	0.75	0.01	2.19	0.88	0.01
ΔR_{t-2}	1.28	0.67	0.06	1.49	0.72	0.04
$Inflation_t$	0.86	0.25	0.00	1.54	0.48	0.00
$Output_t$	0.07	0.16	0.65	0.38	0.17	0.02
$Dissent_{t-1}$	3.36	0.99	0.00	9.05	3.47	0.01
γ_1	-1.30	0.27	0.00	-2.17	0.36	0.00
γ_2	-0.93	0.25	0.00	-1.26	0.27	0.00
γ_3	1.89	0.35	0.00	2.02	0.35	0.00
Goodness-of-fit measures with (without) $Dissent_{t-1}$						
Log Likelihood	-58.51 (-65.54)			-45.62 (-49.32)		
AIC	133.01 (145.09)			107.24 (112.63)		
Adjusted Estrella	0.31 (0.17)			0.42 (0.36)		
McFadden's LRI	0.26 (0.17)			0.35 (0.3)		
McKelvey-Zavoina	0.56 (0.41)			0.64 (0.57)		
Correctly predicted	0.68 (0.56)			0.7 (0.66)		

Table 5. Do dissenting votes help predicting policy decisions?

Forward-looking Taylor rule with interest rate smoothing

Sample	1998/02 - 2004/01			2004/02 - 2009/12		
Parameter	Coeff.	Error	Prob.	Coeff.	Error	Prob.
ΔR_{t-1}	2.31	0.73	0.00	2.74	0.93	0.00
ΔR_{t-2}	1.43	0.64	0.03	1.35	0.76	0.07
$\Delta Expected\ Inflation_t$	-0.05	0.18	0.77	2.21	0.57	0.00
$\Delta Output_t$	0.21	0.15	0.16			
$\Delta Expected\ Output_t$				1.98	0.53	0.00
$Dissent_{t-1}$	3.05	0.93	0.00	10.77	3.76	0.00
γ_1	-1.21	0.24	0.00	-2.54	0.42	0.00
γ_2	-0.86	0.23	0.00	-1.39	0.30	0.00
γ_3	1.43	0.26	0.00	2.24	0.40	0.00
Goodness-of-fit measures with (without) $Dissent_{t-1}$						
Log Likelihood	-66.47 (-72.76)			-40.72 (-45.38)		
AIC	148.93 (159.51)			97.43 (104.76)		
Adjusted Estrella	0.12 (-0.03)			0.52 (0.45)		
McFadden's LRI	0.16 (0.08)			0.42 (0.36)		
McKelvey-Zavoina	0.38 (0.2)			0.72 (0.63)		
Correctly predicted	0.57 (0.44)			0.69 (0.76)		

Table 6. Do dissenting votes help predicting policy decisions?

Empirical model 1 for 1999/02-2004/01 period

Parameter	Coeff.	Error	Prob.	Coeff.	Error	Prob.
I_Exp_Inf - T	1.49	0.81	0.07	3.20	1.03	0.00
ΔCore CPIxac$_t$	2.04	0.79	0.01	4.75	1.34	0.00
ΔCons. Expenditure$_t$	0.76	0.28	0.01	1.66	0.36	0.00
WIBOR6M$_t$ - R$_{t-1}$	1.52	0.49	0.00	2.16	0.56	0.00
ΔWIBOR1Y$_t$	0.41	0.12	0.00	0.76	0.18	0.00
Dissent$_{t-1}$				6.02	1.27	0.00
γ_1	-3.22	0.78	0.00	-5.65	1.14	0.00
γ_2	-2.46	0.69	0.00	-4.32	1.01	0.00
γ_3	5.21	1.09	0.00	9.06	2.07	0.00
Goodness-of-fit measures						
Log Likelihood	-30.56			-19.90		
AIC	77.12			57.79		
Adjusted Estrella	0.66			0.82		
McFadden's LRI	0.52			0.69		
McKelvey-Zavoina	0.91			0.97		
Correctly predicted	0.70			0.87		

Table 7. Do dissenting votes help predicting policy decisions?

Empirical model 2 for 2004/02-2009/12 period

Parameter	Coeff.	Error	Prob.	Coeff.	Error	Prob.
ΔCore CPItri$_t$	2.88	1.48	0.05	6.44	3.16	0.04
ΔExpected Inflation$_t$	2.07	0.98	0.03	5.41	1.80	0.00
ΔOutput$_t$	1.44	0.41	0.00	2.62	0.76	0.00
ΔExpected Output$_t$	1.94	0.57	0.00	4.23	1.50	0.00
ΔWIBOR1M	9.40	2.99	0.00	23.86	6.90	0.00
WIBOR1Y$_t$ - R$_{t-1}$	5.11	1.41	0.00	9.16	2.73	0.00
Economic situation$_t$	0.21	0.07	0.00	0.39	0.12	0.00
ΔExp. Econ. situation$_t$	0.26	0.08	0.00	0.58	0.18	0.00
Dissent$_{t-1}$				24.77	7.67	0.00
γ_1	-6.28	1.55	0.00	-12.92	4.07	0.00
γ_2	-1.65	0.81	0.04	-3.03	1.08	0.00
γ_3	11.75	2.97	0.00	23.65	6.98	0.00
Goodness-of-fit measures						
Log Likelihood	-15.17			-10.53		
AIC	52.34			45.06		
Adjusted Estrella	0.86			0.90		
McFadden's LRI	0.79			0.85		
McKelvey-Zavoina	0.98			0.99		
Correctly predicted	0.87			0.93		

Table 8. Comparison with market anticipation

Sample	1999/02-2004/01		2004/02-2009/12	
Model	Correctly predicted decisions out of 60	Average likelihood of observed decisions	Correctly predicted decisions out of 71	Average likelihood of observed decisions
Reuters survey of bank analysts	50 (83%)	0.77	62 (87%)	0.82
Empirical model	42 (70%)	0.70	62 (87%)	0.86
Empirical model with *Dissent*	52 (87%)	0.80	66 (93%)	0.90

Figure 1. Historical changes to the reference rate, %

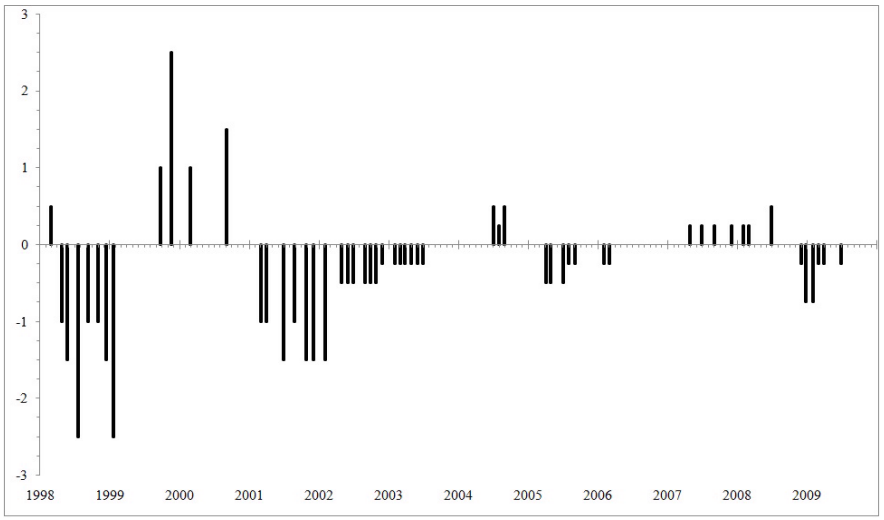


Figure 2. Difference between announced and average proposed changes to the reference rate, %

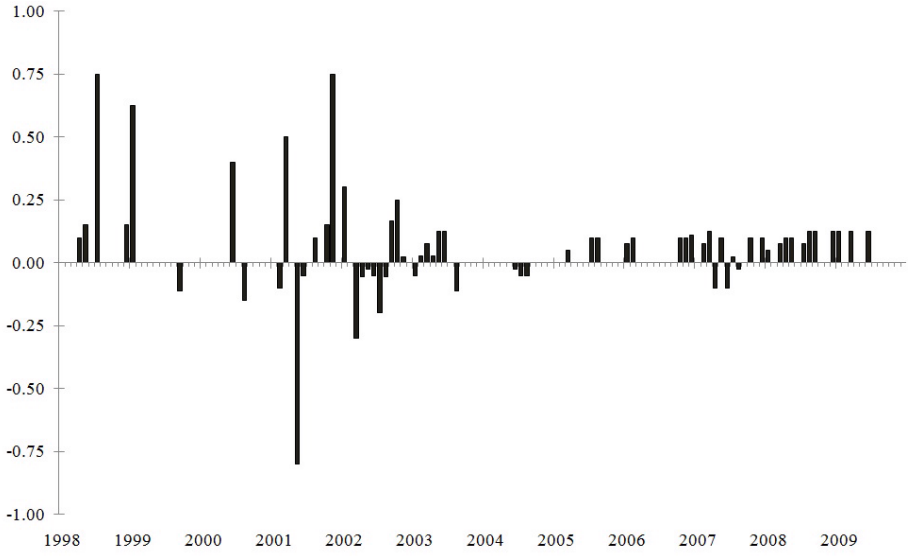
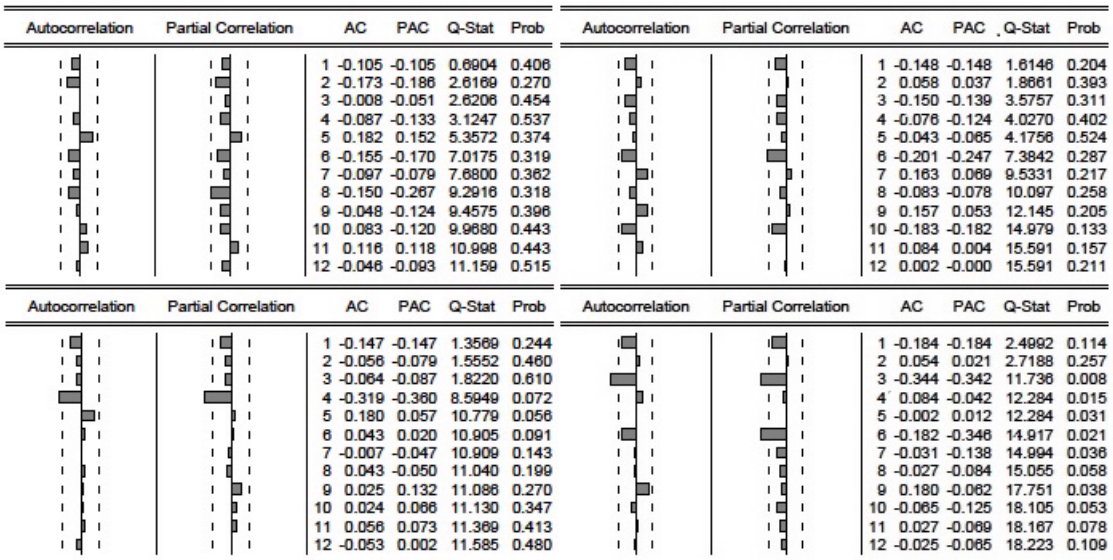


Figure 3. Correlograms of generalized residuals

Empirical Model 1 (1999/02 - 2004/01) Empirical Model 2 (2004/02 - 2009/12)



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.105	-0.105	0.6904	0.406
		2	-0.173	-0.186	2.6169	0.270
		3	-0.008	-0.051	2.6206	0.454
		4	-0.087	-0.133	3.1247	0.537
		5	0.182	0.152	5.3572	0.374
		6	-0.155	-0.170	7.0175	0.319
		7	-0.097	-0.079	7.6800	0.362
		8	-0.150	-0.267	9.2916	0.318
		9	-0.048	-0.124	9.4575	0.396
		10	0.083	-0.120	9.9680	0.443
		11	0.116	0.118	10.998	0.443
		12	-0.046	-0.093	11.159	0.515

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.148	-0.148	1.6146	0.204
		2	0.058	0.037	1.8661	0.393
		3	-0.150	-0.139	3.5757	0.311
		4	-0.076	-0.124	4.0270	0.402
		5	-0.043	-0.065	4.1756	0.524
		6	-0.201	-0.247	7.3842	0.287
		7	0.163	0.069	9.5331	0.217
		8	-0.083	-0.078	10.097	0.258
		9	0.157	0.053	12.145	0.205
		10	-0.183	-0.182	14.979	0.133
		11	0.084	0.004	15.591	0.157
		12	0.002	-0.000	15.591	0.211

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.147	-0.147	1.3569	0.244
		2	-0.056	-0.079	1.5552	0.460
		3	-0.064	-0.087	1.8220	0.610
		4	-0.319	-0.360	8.5949	0.072
		5	0.180	0.057	10.779	0.056
		6	0.043	0.020	10.905	0.091
		7	-0.007	-0.047	10.909	0.143
		8	0.043	-0.050	11.040	0.199
		9	0.025	0.132	11.086	0.270
		10	0.024	0.066	11.130	0.347
		11	0.056	0.073	11.369	0.413
		12	-0.053	0.002	11.585	0.480

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.184	-0.184	2.4992	0.114
		2	0.054	0.021	2.7188	0.257
		3	-0.344	-0.342	11.736	0.008
		4	0.084	-0.042	12.284	0.015
		5	-0.002	0.012	12.284	0.031
		6	-0.182	-0.346	14.917	0.021
		7	-0.031	-0.138	14.994	0.036
		8	-0.027	-0.084	15.055	0.058
		9	0.180	-0.062	17.751	0.038
		10	-0.065	-0.125	18.105	0.053
		11	0.027	-0.069	18.167	0.078
		12	-0.025	-0.065	18.223	0.109

Notes: Specifications without (with) *Dissent* are above (below).

Figure 4. Actual and predicted changes to the reference rate

Empirical Model 1 (1999/02 - 2004/01)

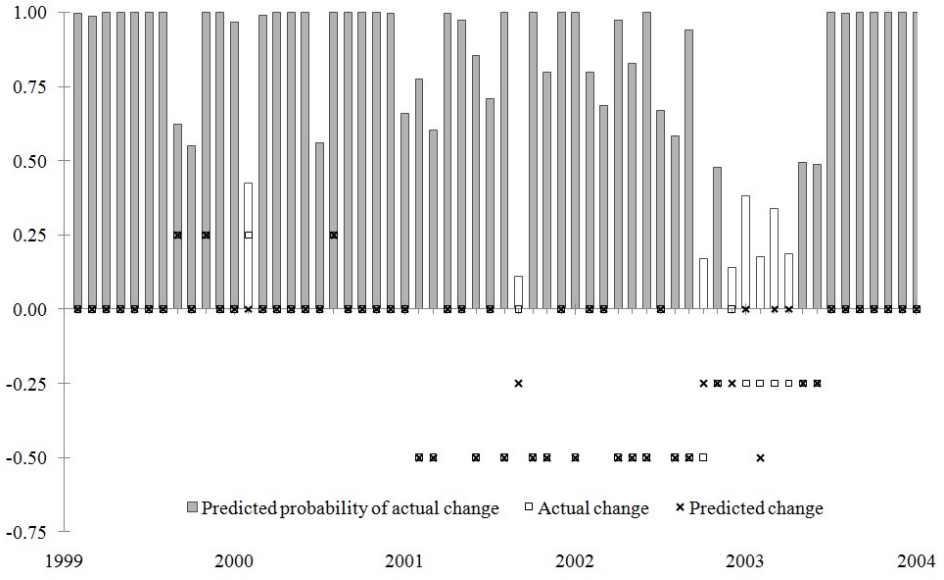


Figure 5. Actual and predicted changes to the reference rate

Empirical Model 2 (2004/02 - 2009/12)