Alexander Jung–Gergely Kiss

Voting by monetary policy committees: evidence from the CEE inflation-targeting countries

MNB WORKING PAPERS 2
2012

MAGYAR NEMZETI BANK

Alexander Jung–Gergely Kiss

Voting by monetary policy committees: evidence from the CEE inflation-targeting countries

MNB WORKING PAPERS 2
2012

The MNB Working Paper series includes studies that are aimed to be of interest to the academic community, as well as researchers in central banks and elsewhere. Starting from 9/2005, articles undergo a refereeing process, and their publication is supervised by an editorial board.

The purpose of publishing the Working Paper series is to stimulate comments and suggestions to the work prepared within the Magyar Nemzeti Bank. Citations should refer to a Magyar Nemzeti Bank Working Paper. The views expressed are those of the authors and do not necessarily reflect the official view of the Bank.

MNB Working Papers 2012/2

Voting by monetary policy committees: evidence from the CEE inflation-targeting countries*

(Szavazás a monetáris tanácsokban: inflációs célkövetést alkalmazó kelet-közép-európai országok tapasztalatai)

Written by: Alexander Jung**, Gergely Kiss***

Published by the Magyar Nemzeti Bank

Publisher in charge: dr. András Simon, Head of Communications

8–9 Szabadság tér, H–1850 Budapest

www.mnb.hu

ISSN 1585-5600 (online)

* The authors thank Laszlo Halpern for raising the issue, seminar participants at the Magyar Nemzeti Bank (the central bank of Hungary), including members of the Hungarian Monetary Council, Michael Ehrmann, Jean-Pierre Vidal, Jacek Kotlowski, Szilárd Erhart, Jonathan Cook, Pavel Gertler, Makram El-Shagi, Marcello Sanchez, Francesco-Paolo Mongelli, and two anonymous referees for their comments. The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank and the Magyar Nemzeti Bank (for which G. Kiss worked when the study was prepared). The authors remain responsible for any errors or omissions.

** Alexander Jung (corresponding author, E-mail: alexander.jung@ecb.europa.eu) is Senior Economist at the European Central Bank, Directorate Monetary Policy.

*** Gergely Kiss (E-mail: gergely.kiss@fitchratings.com) is Director at Fitch Ratings, Sovereign Group.

Contents

Abstract

The aim of this paper is to study preference heterogeneity in monetary policy committees of inflation-targeting (IT) countries in Central and Eastern Europe (CEE) during the period 2005–2010. It employs (individual) voting records of the Monetary Council of the Magyar Nemzeti Bank (the central bank of Hungary) and of the Monetary Policy Council of the National Bank of Poland. Preference heterogeneity in committees is not directly observable. Therefore, we pursue an indirect measurement and conduct an econometric analysis based on (pooled) Taylor-type reaction functions estimated using real-time information on economic and financial indicators and voting records. Recent evidence for the monetary policy committees (MPCs) of advanced economies (see Besley et al., 2008; and Jung, 2011) suggests that preference heterogeneity among its members is systematic. Unlike for monetary policy committees of advanced countries, the present paper finds preference heterogeneity to be random for both the members of the Monetary Policy Council of the National Bank of Poland (NBP), and the members of the Monetary Council of the Magyar Nemzeti Bank (MNB). But, similar to the committees of advanced economies, the diversity of views on the inflation forecast is measurable in both committees. A separate cluster analysis shows that different preferences of MPC members may be attributable to their status (chairman, internal member, external member) and that members may also differ in their desired response to changes in the economic outlook.

JEL: C23, D72, D83, E58.
Keywords: central banking, monetary policy committee, inflation targeting, collective decision-making, voting, preferences, pooled regressions.

Összefoglalás

A tanulmány az inflációs célkövetést alkalmazó kelet-közép-európai országok monetáris döntéshozó testületeiben vizsgálja a preferenciák heterogenitását 2005 és 2010 között. Ehhez a magyar és a lengyel nemzeti bank monetáris tanácsainak név szerinti szavazatait használja. Mivel a preferenciák heterogenitása közvetlenül nem megfigyelhető, az ökonometriai elemzés indirekt módszert alkalmaz: összevont (pooled) Taylor-típusú reakciófüggvényt becsül valós idejű gazdasági és pénzügyi információk és az egyéni szavazatok alapján. A fejlett gazdaságok monetáris tanácsaira vonatkozó friss eredmények (Besley et al., 2008; Jung, 2011) szerint a monetáris tanácstagok közötti heterogenitás szisztematikus. Ezzel szemben e tanulmány eredményei azt mutatják, hogy mind a magyar, mind a lengyel tanácsban véletlenszerű a preferenciák heterogenitása. Mindazonáltal a fejlett országokhoz hasonlóan az inflációs előrejelzéssel kapcsolatos vélemények eltérése mindkét testületben számottevő. A klaszterelemzés eredményei szerint a tagok preferenciáinak eltérése köthető a tanácsban betöltött szerephez (elnök, belső, külső tag), valamint a tagok között különbség lehet abban is, ahogyan a gazdasági kilátások változásaira kívánnak reagálni.

1 Introduction

The global march towards greater transparency has reached the countries of Central and Eastern Europe (CEE). In recent years, more information on the monetary policy processes of the CEE central banks has been made available to the public. Overall, inflation targeting frameworks in the CEE countries have performed remarkably well during the past decade. The increased popularity of inflation targeting (IT) has led to visible improvements regarding transparency and accountability in monetary policy. Other main benefits typically associated with inflation targeting are the following. First, inflation targeting successfully lowers inflation and makes it less volatile. Second, it reduces the real costs of disinflation. Third, it anchors long-run inflation expectations. An ongoing debate is whether inflation targeting countries perform better than those that have other monetary policy strategies. Blinder et al. (2008) suggest that many studies provide clear evidence that the IT strategy has succeeded in anchoring inflation expectations. While most economists would subscribe to this view for advanced economies, it is less clear whether for economies in transition a similar point can be made. In studies that include emerging economies and CEE countries, Goncalves and Salles (2008) and Lin and Ye (2009) report significant positive effects of inflation targeting, whereas Brito and Bystedt (2010) find that inflation targeting regimes do not lower the costs of disinflation.

Nowadays, it is widely established practice that monetary policy decisions are made by a committee and not by a single policy-maker (examples of central banks with a single policy-maker in charge of monetary policy are the Reserve Bank of New Zealand and the Bank of Israel). In committees, as illustrated by the popular hawk-doves analogy, it is widely taken for granted that its members have different preferences. Nevertheless, monetary policy committees keep the dynamics of their regular committee interactions confidential (see Bank for International Settlements, 2008 and 2009). If not communicated, policy-makers' individual preferences will therefore not be observed by the public in real-time. More openness on the motives of individual policy-makers and the way they make decisions could help the public to better understand and predict their decisions. Several tools exist by which central banks may communicate the degree of consensus on policy rates among committee members. The conventional spectrum includes transcripts, minutes and voting records of the committee meetings, which to a varying degree and timeliness provide information on the diversity of views in the committee. In the CEE, three central banks [the central bank of Hungary (Magyar Nemzeti Bank, MNB) since 2005, the National Bank of Poland (NBP) since 1998, and most recently the Czech National Bank (CNB)] have published (individual) voting records which contain information on agreement and dissent by member shortly after the policy meeting. Such voting records are an important source on diversity among policy-makers in these committees but they have known shortcomings. It has been shown for the Federal Open Market Committee (FOMC) that members of a policy committee may not always reveal their "true" preferences in public (see Meade, 2005; McCracken, 2010). Blinder (2007) attributes this phenomenon to the practice of policymaking by consensus that would suppress public dissent. Available evidence for CEE countries suggests that voting records may contain valuable information about agreement and dissent by members and about future interest rate moves (see Horváth, Smidková and Zápal, 2010).

The present paper aims to study heterogeneity in policy preferences among committee members in those CEE countries for which voting records are available for a sufficient long period. It makes a contribution to the literature by providing and comparing empirical evidence on preference heterogeneity among inflation-targeting CEE countries during the period 2005–2010. Given that neither preference heterogeneity nor diversity of views in committees is directly observable, we pursue an indirect measurement and conduct an econometric analysis based on (pooled) Taylor-type reaction functions. These we estimate using real-time information available from published inflation reports and (individual) voting records. The empirical analysis includes the Monetary Policy Committee of the central bank of Hungary (Magyar Nemzeti Bank, MNB) and the Monetary Policy Council of the National Bank of Poland (NBP) during the period 2005–2010.

The paper is organized as follows. Section 2 briefly reviews why heterogeneity is a factor in the monetary policy process involving committees. Section 3 explains the monetary policy process in two inflation targeting central banks in the CEE, the MNB and NBP. Section 4 provides the results from an econometric analysis on preference heterogeneity. Section 5 concludes.

2 Heterogeneity in the monetary policy process

Interactions between members of a monetary policy committee are complex and involve frequent meetings. Extensive internal discussions aim at facilitating a joint assessment of the economic outlook and of its implications for the monetary policy stance. Discussions in committees require considerable staff input. In this respect, Csajbók (2008) finds that inflation targeting central banks and, what he calls consensus-seeking MPCs, rely more on staff input than other central banks. Information by staff is normally accessible by all committee members, and represents information common to all members. Prior to each committee meeting committee members collect information relevant for the policy decision and share the available information and expertise at policy meetings.

Learning among peers has several benefits (see Blinder et al., 2008 and Jung, Mongelli and Moutot, 2010). It is part of the committee interaction and makes monetary policy decisions in the presence of uncertainty more robust. Most central banks provide no detailed information regarding this aspect of the decision making process by monetary policy committees. The information cascade model (see e.g. Bikhchandani, Hirshleifer and Welch, 1998) suggests that in an uncertain environment committee members do not simply form their views based on their own information set obtained prior to the meeting, but also take into account the opinions expressed by fellow members, speaking earlier during the discussion. An exchange of views about the economic outlook among members in a confidential environment contributes to a well informed decision. At the end of each meeting the committee has to take a monetary policy decision which is either an unchanged monetary policy stance or an adjustment of policy rates.

Diversity across policy-makers is an important feature of voting by monetary policy committees. The literature on monetary policy committees widely emphasises that diversity in monetary policy committees has beneficial effects which makes them superior to single individuals (see Blinder, 2004; Blinder et al., 2008; Mihov and Sibert, 2006; Bank for International Settlements, 2009). It is thus no surprise that in a clear majority of central banks committees are in charge of interest rate decisions. Nevertheless, the practice of revealing the diversity of views within the committee is far less uniform. Benefits and costs have to be weighed. Revealing diversity may make a central bank more predictable, thereby helping it to better anchor inflation expectations and to smooth volatility. At the same time, communicating diversity may distort the process of accountability, if the committee wants to emphasise collective and not individual accountability.

It is widely observed that committee members have different preferences. For example, Blinder (1998) observes that members in a committee have different preferences and need to compromise positions. For that reason, he suggests that the "central tendency" in a committee is by far more inertial (i.e. less variable) than that of a single policy-maker. Heterogeneity in a monetary policy committee is often related to different skills and backgrounds and to different preferences or views of its members. Most studies though are not clear about the factors driving diversity in the committee. Is it the result of different preferences among policy-makers, as the Hawks-Doves model would predict, or is it the result of different views on economic data or is it owing to information asymmetries in the committee?

In the deliberations of monetary policy committees, policy-makers with different preferences may disagree on what constitutes the most appropriate policy response even though they fully share the strategy and the goal(s) of the central bank. In committee interactions information asymmetries may arise, because members have different professional backgrounds, information processing skills, and members may have "private" information which they do not share with their peers. Information asymmetries can also grow with the size of the committee (see Erhart and Vasquez-Paz, 2007). According to Sibert (2002) "groupthink" can occur if the same members meet regularly. Groupthink implies that individual members have an incentive to hide their disagreement, thereby making it impossible to distinguish between individual and collective preferences of committee members.

Table 1
Key voting characteristics of monetary policy committees in Europe

	CEE countries			Western European countries		
	Magyar Nemzeti Bank (the central bank of Hungary)	**National Bank of Poland**	**Czech National Bank**	**Bank of England**	**Sveriges Riksbank**	**ECB**
Number of voting members	**7**	**10**	**7**	**9**	**6**	**23**
Internal members	3	1	7	5	6	6
External members	4	9	0	4	0	17
Changes in the committee size	Gradual decrease in the number of members to 7	Unchanged	Unchanged	Unchanged	Unchanged	Increase in the number of external members
Number of regular meetings on monetary policy[a]	**12**	**12**	**8[b]**	**12**	**6**	**12**
Meetings with changes in policy rates (period 2005 to 2010)	24	21	19	15	24	15
Meetings with **no** changes in policy rates (period 2005 to 2010)	38	51	33	45	16	45
"Activism" ratio						
Frequency of policy rate changes in relation to number of meetings (period 2005 to 2010)	39%	29%	32 (26)%[c]	25%	60 (30)%[c]	25%

Notes: Most interest rate changes in the sample were by 25 or 50 basis points. a) Including unscheduled meetings such as conference calls. b) Prior to 2008 the number of meetings per year was 12. c) Value in brackets denotes approximate ratio based on monthly meetings for better comparability.

Monetary policy committees can often be distinguished regarding their composition in terms of external and internal members (see Table 1). In committees that distinguish between the appointment of internal and external members or between members at the centre and in the regions, preference heterogeneity has sometimes been attributed to the membership status. Several studies for the Bank of England's MPC suggest that external members would dissent more frequently, tend to be more dovish than internal members and contribute to lower interest rates (see Gerlach-Kristen, 2003a and 2009; Spencer, 2006). A study by Berk, Bierut and Meade (2010) suggests that these differences would be mainly related to the end of their tenure. While it is theoretically plausible to expect that members may get more hawkish towards the end of their tenure (see Mihov and Sibert, 2006), reappointments are infrequent in practice, thus making it difficult to trace tenure effects. Evidence from the FOMC on preference heterogeneity between Governors and Bank Presidents is more mixed. While in one of the first analyses on that subject Tootell (1991) rejected preference heterogeneity on regional grounds, several studies examining votes cast by FOMC members in the 1990s find that policy-makers' interest rate preferences are sensitive to regional unemployment rates (see Meade and Sheets, 2005; Chappell, McGregor, and Vermilyea, 2008; McCracken, 2010).

In the CEE region there may be also differences between central bank committees along these lines. We focus on the three largest countries (Poland, Hungary, and Czech Republic). At the MNB, there is traditionally an overweight of external members. Similarly, the monetary policy committee of the NBP comprises 9 external members, and only the chairman is an internal member. At the CNB, the distinction is not relevant, because all members are internal members like in Sweden. It is also noteworthy that over time the overweight of the external members at the MNB has become much smaller. In 2005, with 13 members (4 internal and 9 external), there was still a clear balance in favour of the external members, more like in Poland. Since 2009, with a total of 7 members (3 internal and 4 external members) the balance has changed towards parity, and the overweight of the external members has been reduced to one member. This has to be seen against the background that frequent changes in the central bank law have reduced the committee size in Hungary gradually from 13 to 7 members in Hungary, whereas the size of the committees in Poland and the Czech Republic has remained unchanged.

3 Decision-making in selected CEE inflation-targeting countries

IT central banks are known for their high standards in terms of transparency on monetary policy (for a comparison see Eijffinger and Geraats, 2006). They have in common that they disclose a wide range of information on the monetary policy process. In addition to the publication of detailed macroeconomic forecasts in the Inflation Reports, this may include the publication of MPC minutes, and possibly individual voting records.[1] Based on a survey of central bank practice on transparency, Dincer and Eichengreen (2007 and 2009) find that CEE countries with an IT regime have greatly improved over the last decade and are broadly comparable to countries in Western Europe. Though, only a few CEE countries have, by now, published data on individual voting records for a sufficient long time span that can be used to carry out formal, quantitative analysis (see Bank for Internatioal Settlements, 2008).

In the CEE, three central banks have published (individual) voting records which contain information on agreement and dissent by member shortly after the policy meeting: these have been since 1998 the NBP, since end-2004 the MNB, and since 2006 the CNB have published attributed voting records. From 2000 to 2006, the CNB only published the balance of votes without attribution to individual board members. More recently, the CNB has started publishing the transcripts of past meetings (six years back), so that in total attributed voting records for a disconnected time span of 1998–2004 and 2008-2011 are available at the moment. While this suffices for certain analyses of voting patterns (for an analysis of the CNB's voting records see Horváth et al., 2010), the present method using reaction functions with real-time data requires a coherent data set with at least 40 to 50 observations. Based on CNB's current publication policy, the gap will disappear

Table 2
Key elements of the monetary policy process in Hungary and Poland

Element	Hungary	Poland
Monetary policy committee		
a) Name of the committee	Monetary Council	Monetary Policy Council
b) Meeting frequency	monthly	monthly
c) Interest rate proposal	tour de table opened by the chief economist	each member may propose a "motion" on interest rates
Monetary policy strategy		
a) Adoption	IT since mid-2001	IT since 1998
b) Inflation target	3.0% (headline CPI)	2.5% ±1% tolerance band (headline CPI)
c) Exchange rate regime	floating	freely floating
Main inputs to interest rate decisions		
a) Staff projections	quarterly	three times a year
b) Interest rate assumption	constant interest rates*	market interest rates (main)/ constant interest rates (alternative)
c) Other inputs	scenario analyses wide range of economic, financial, monetary variables	scenario analyses wide range of economic, financial, monetary variables
External communication		
a) Inflation reports	quarterly	three times a year (since 2008)
b) Minutes	since end-2004	since 2007
c) Voting records	since end-2004	since 1998
d) Other tools	fan charts, statements	fan charts statements (including monetary policy bias until January 2005)

*Note: * in 2011 the MNB introduced an endogenous path.*

[1] For the monetary policy committees of several IT central banks voting records are available: Sweden, the UK, Brazil, Czech Republic, Hungary, Poland, Korea, Philippines, and for a few non-IT central banks: the US and Japan.

by 2014. Only then it will be possible to apply the approach pursued this paper for a consecutive 15 year long dataset of the CNB.[2]

In the remainder of this paper we therefore focus on two of these three largest CEE countries, Hungary and Poland. Both economies are relatively small, with open capital accounts and very strong trade and financial links to the euro area. Since 2004 Hungary and Poland are members of the EU. They have adopted a flexible exchange rate regime, and do not participate in the exchange rate regime ERM II. The law in both countries grants the central bank with full independence in the pursuit of the primary objective, price stability. As we will discuss below (for a summary see Table 2), the MNB and the NBP share several features concerning the monetary policy process, but there are also some differences.

3.1 THE CASE OF HUNGARY

Hungary introduced inflation targeting in mid-2001, when inflation was around 10%. The choice of a new nominal anchor was a large shift in monetary policy following the exchange rate-based monetary regimes that were in place since the beginning of the transition in 1990. Various elements of a fully fledged IT regime have been in place from the beginning. Since 2005, the central bank of Hungary (MNB) has set a medium-term inflation target of 3% defined in terms of headline CPI. The transmission of monetary policy works via the interest rate channel, the exchange rate channel and the expectations channel. For some time, given the relatively underdeveloped financial markets, the most important transmission channel of monetary policy was the direct effect of the exchange rate on traded prices and thus on inflation. By now, due to the growing share of foreign exchange loans the monetary transmission through the exchange rate has changed substantially (see e.g. Endrész and Krekó, 2010).

As Csermely (2006) observes, the MNB faced initial weaknesses with the IT strategy. First, IT was introduced while an exchange rate band was still in place, though it was much wider than previously (a 'shadow ERM II' with ±15% band around the euro). Second, the support of fiscal policy was essentially missing: the lack of fiscal discipline was accompanied by the frequent misses of euro adoption target dates set by the government, which in turn always triggered a large risk premium shock, further complicating the conduct of monetary policy. Moreover, in the first years of the IT regime, policymakers adopted a consensual style of decision-making and their communications on interest rate decisions mainly relied on the statement of the Monetary Council (followed by a more detailed quarterly Inflation Report). No minutes were published and no indications on the individual votes were disclosed.

After the first experience, a number of adjustments were made to the IT framework. The Bank reduced inflation with gradually decreasing inflation targets, an approach that bears resemblance to the Bank of Canada's positive experience with time-varying inflation control targets in the early 1990s. Though, it was an attempt to address the inherent conflict between meeting the inflation target and stabilising the Forint within the exchange rate band. This was apparent from a speculative attack on the exchange rate band in early 2003. Following this episode, the MNB took further measures. It became more careful in its communications in times when a potential conflict between the inflation targets and the exchange rate band could arise. In 2005, the MNB adopted a permanent, medium-term inflation target (effective from 2007), thereby marking a departure from the setting of short-term (annual) targets and moving closer to the approach of the leading contenders in IT. Then, in February 2008 the MNB adopted a floating exchange rate regime for the forint/euro exchange rate.

The Bank's Inflation Report is a key channel for the MNB's communications with the public. In its Inflation Report the Bank provides a forward-looking assessment of the economic situation and illustrates its risk assessment using fan charts. The MNB explored further ways on how to reveal diversity of the internal deliberations to the public. Effective the meeting of December 2004, the MNB published minutes of the Monetary Council deliberations together with members' votes. Initially these minutes included only the balance of votes without attribution to members. Since October 2005 individual votes of committee members have been reported. The main motivation behind the publication of minutes was to increase transparency regarding the diversity of views within the MPC, thereby making the central bank more predictable (see Tóth, 2006). On one occasion though, the MNB decided to abstain from disclosing information on diversity among committee

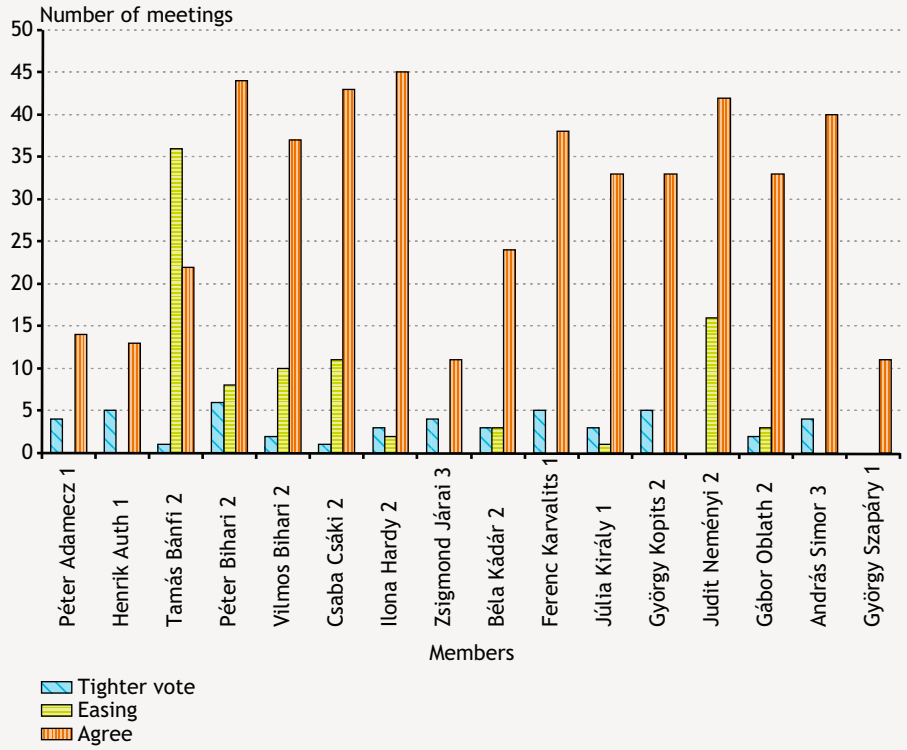
[2] The analysis of the voting records of the CNB is therefore a possible topic for further research.

members. At the peak of the financial turmoil in October 2008, the Monetary Council held an unscheduled meeting at which it decided to increase key interest rates by an amount of 300 basis points without revealing the individual votes for that meeting.

In terms of monetary policy deliberations, the Monetary Council holds monthly meetings, but does not hold pre-MPC meetings, like e.g. the ECB's Governing Council. As input to these meetings central bank staff prepares detailed macroeconomic forecasts each quarter, which are published in the Bank's Inflation Report after an internal discussion has been held. These staff projections were initially conditional on unchanged policy rates and exchange rates. Effective March 2011, the MNB changed the interest rate assumption and has used an endogenous interest rate path (see Magyar Nemzeti Bank, 2011). If projections depart from the inflation target on the horizon relevant for monetary policy, the Bank would consider a change of its key interest rates. For policy-makers the difference between the central path and the inflation target, the degree of uncertainty around the central path, as well as the direction of risks may matter in this respect. At the official meeting, the Chief Economist of the MNB (i.e. the deputy governor in charge of the Department of Economics) usually opens the interest rate setting discussion. Other committee members reveal their preferred interest rate options during a first exchange of views. Like is now practice at the FOMC, the chairman reveals his preference at the end of this "tour de table". He gives a summary of the first round of interventions and takes stock of possibly different interest rate options raised by the committee members. During a second round members are given the opportunity to comment on the options considered. Following this exchange of views members formally vote on the options and agree on the precise wording of the MPC statement that is published shortly after the meeting.

Currently, the Monetary Council consists of three internal members (the governor and deputy governors) and 4 external members, all appointed for a six year term. Its size has changed frequently but this has not changed the fact that external members are in a structural majority. In March 2005, the government initiated an amendment to the appointment rules of MPC members, which led to the appointment of four new external committee members, all of whom were nominated by the prime minister. Thereby the size of the committee increased to 13 members but later, given changes in appointment

Chart 1
Votes by members of Hungary's Monetary Council (2005 to 2010) relative to the actual decisions taken



Notes: Membership takes different values. 1: internal member, 2: external member and 3: chairman; only those meetings are reported at which the respective member was present.
Source: MNB.

rules, the number of members gradually decreased to the currently prevailing level of 7 members. As a result the total number of votes cast varied considerable. The often amended appointment rules aiming at changing the composition and size of the committee and thus the balance of votes mirror mounting public confrontations between the MNB and the government on what constitutes appropriate monetary policy. Governor Járai characterized his term during the press conference following his last rate setting meeting in February 2007 "as one year of work and five years of fighting". This can also underline that the institutional tensions resulted in increasing dissent within the Monetary Council.

Between 2005 and 2010 only 25% of the decisions were taken by unanimity. With around 39%, the average "activism" ratio (i.e. the number of meetings with changes in policy rate as a share of all meetings in that period) was fairly high by international comparison. Chart 1 provides an illustration of the directional dissents by members. It may give first indications on the preference distribution in the committee and it may be a reflection of time-varying uncertainty. The balance between agreement and dissent, and also its direction, is different between internal and external members. Internal members are more consensual with the decision finally taken by the committee. If they dissent it is seldom in favour of easing, but most of the times in favour of tightening policy rates. By contrast, external members may dissent in either direction but most of their dissenting votes have been in favour of easing rather than tightening policy rates. In a five years period, dissenting in favour of easing amounted to more than 50% of the decisions taken. Like for the Bank of England's MPC, the Governor of the MNB was outvoted several times (e.g. Governor Járai almost every month around the end of a tightening cycle in late 2006, i.e. four times between October 2006 and February 2007; Governor Simor in March 2009, at the beginning of the easing cycle in July 2009, and in August 2010, when the majority of the Council did not yet want to start a tightening cycle).

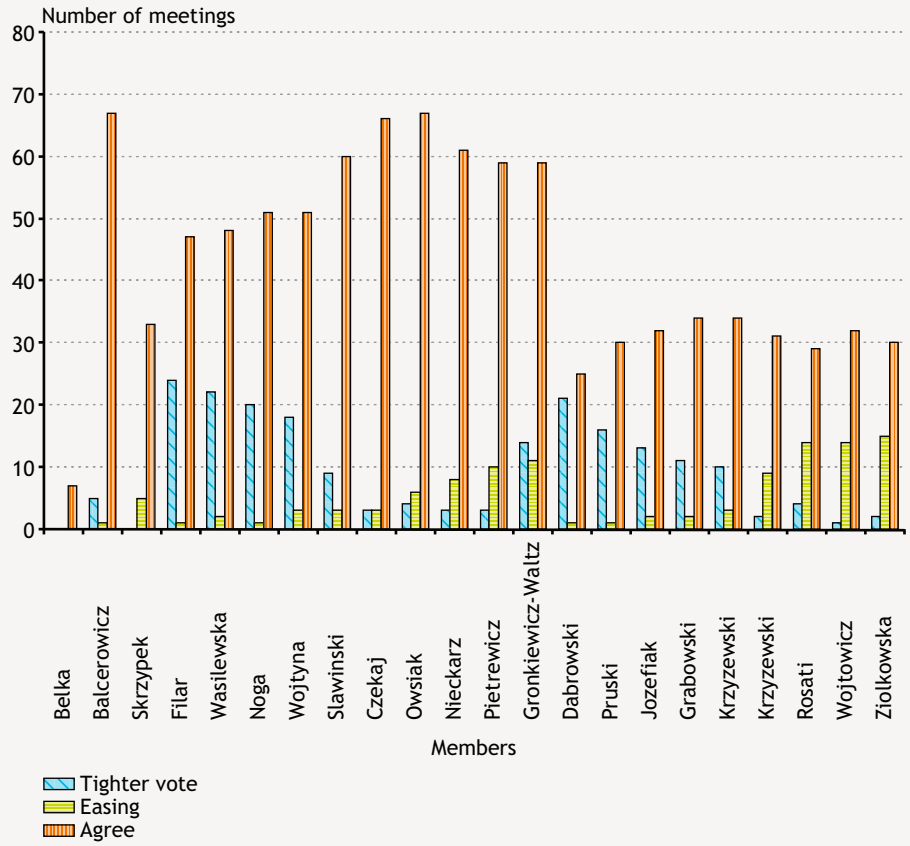
3.2 THE CASE OF POLAND

After the turbulent times in the early years of the transition with high inflation rates in the range of 11-13 per cent, the NBP abandoned the exchange rate based monetary regime and introduced inflation targeting in 1998. In a first phase inflation targets, defined in terms of headline CPI, were set with the aim to gradually reduce inflation below the 4 per cent level within four years (see NBP, 1998). In a second phase (in 2002 and 2003), when actual inflation was below the inflation target, the central bank decided to lower the inflation target to 2.5 per cent with a ±1 per cent tolerance band (see NBP, 2003). With the setting of a permanent inflation target the IT regime unfolded its stabilising forces on prices. From 2004 to 2010 the average inflation in Poland was 2.75 per cent. The small target deviation of on average only 0.25 per cent is an outstanding performance by international standards. In 2000, two years after the IT regime was introduced, Poland abandoned its crawling-peg/band regime to a basket comprising the US dollar and the euro. This meant that the Zloty became a freely floating currency. Like in Hungary, the switch to a flexible exchange rate regime helped the Bank to achieve this remarkable disinflation process.

Like for the MNB, the Bank's Inflation Report is a key channel for its communications with the public. The NBP made several improvements of its communication policy aimed at convincing the public that it was fully committed to achieving its inflation target. One of the elements in this respect was the publication of information regarding the individual votes of the members of the Monetary Policy Council. Initially, voting records were published with such a long lag that they did not usefully contribute to the understanding of the monetary policy process in real-time. Since 2001, with the inclusion of voting records in the quarterly Inflation Report, they are timelier than before. Another element was that the information content of the Inflation Report was substantially enhanced. For example, since 2004 forward-looking information with a risk assessment in the form of fan charts has been published. In addition, the format of the statements and press conferences of the Monetary Policy Council changed. Initially, the monetary policy decision was only explained if the interest rate was changed. During 2000 to end-2005, the NBP gave regular explanations for each decision including a formal vote on the policy bias. Like for the US Federal Reserve, this "bias" could lean towards tightening, neutral or easing and was discontinued.

In terms of monetary policy deliberations, the Monetary Policy Council takes its decisions at the official monthly rate setting meeting. The Monetary Policy Council receives short-term forecasts on a monthly basis and longer-term projections based on two different macro forecasting models on a quarterly basis (since 2008 only three forecasting exercises per year are conducted). During the internal deliberations members discuss prominently the staff forecast that is conditional on market interest rates and is based on the NECMOD model. Alternatively, staff forecasts based on constant interest rates are prepared and these forecasts are officially published. At the meeting each member may express his/her interest rate

Chart 2
Votes by members of Poland's Monetary Policy Council (2004 to 2010) relative to the actual decisions taken



Notes: All members except the chairman (Balcerowicz, Skrzypek, Belka) are external members; only those meetings are reported at which the respective member was present.
Source: NBP.

preference and propose a "motion" to change interest rates. This may lead to different interest rate proposals. Following an exchange of views on the outlook during which member may make an interest rate proposal, the chairman selects the most "extreme" proposal and holds a vote on it. If there is no majority, he chooses the next proposal and holds a vote and continues this procedure until a majority is in favour of that option (see Sirchenko, 2011). Then, the chairman concludes the discussion. At the end of the meeting, members also agree (but do not vote) on a press release with information on the rationale behind the interest rate decision. In line with this voting methodology the NBP, like the US Federal Reserve, only provides precise quantitative information regarding those committee members who voted in favour of the interest rate proposal. For the dissenters, it does not always provide direct information by which amount they dissented. We could map the individual vote by assuming that dissenters voted for the status quo option or, whenever more than one motion was put to voting the interest rate preferences by members were more clearly identifiable.

As stipulated in the "new" Central Bank Act of 1997 the Monetary Policy Council comprises 10 members with (non-staggered) six year-mandates. The NBP President (i.e. committee chairman) is the only internal member and is responsible for the staff of the central bank. Of the 9 external members, 3 members each are appointed by the upper house of Parliament, its lower house, and the President of the Republic. Hence, external members have an overwhelming majority in the MPC. A unique element of the appointment process of the NBP is that the contracts of all 9 external members expire at the same time (this was the case in 2004 and 2010). The President also has a six-year term and may be seen as the only source of continuity when new members are appointed, because his contract is de facto staggered.[3]

[3] The reason for it was that the first chairwoman Gronkiewicz-Waltz had resigned three years earlier than foreseen (in December 2000). Moreover, in 2010, due to the tragic Polish airplane crash involving NBP President Skrzypek, the new chairman Belka took office in April, just 4 months after the appointment of the 9 new MPC members.

While data are available for the 2000 to 2010 period, we focus on the narrower period since 2004, when the complete team of external members was exchanged, and for which a direct comparison with Hungary is possible (for a discussion of the 1998 to 2004 sample see Sirchenko, 2011). During this time around 60% of the decisions were taken by unanimity, a ratio that is high compared with the MNB. The voting statistics also show that under chairman Balcerowicz the committee voted more consensual than under chairman Skrzypek. At the same time, the "activism" ratio was with 29% significantly lower than in Hungary (see Table 1). While together with the observation for Hungary this seems to suggest that dissent in these committees is related to the frequency of policy rate changes, the case of the Fed's FOMC which has a high "activism ratio" (around 50%) but few dissents would clearly contradict this logic (see Jung, 2011). Chart 2 shows the individual dissents by direction for the NBP. The NBP Presidents had very low dissent ratios, with chairman Balcerowicz slightly on the tightening side and chairman Skrzypek slightly on the easing side. Most external members were more strongly biased in their dissents, typically either in favour of tightening or easing. The dissent ratios were higher in the case of those members who generally preferred a tighter monetary stance. Like in Hungary, the President of the NBP was outvoted several times (e.g. chairman Balcerowicz in July, August 2005 and January, February 2006; chairman Skrzypek in April, June, August 2007 and November 2008 and February 2009).

4 Empirical evidence on preference heterogeneity in the CEE countries

The idea that monetary policy-makers may address uncertainties and minimize the inflation bias by following a simple policy rule was popularized by Taylor (1993) and goes back to Milton Friedman (1960). From the debate on rules versus discretion, it is well known that, when setting interest rates, policy-makers consider various aspects that cannot be captured by means of a simple rule. For example, they typically consult a broad range of indicators and a suite of models in their assessments of inflationary risks. Hence, when estimating empirical reaction functions, we do not assume that policy-makers de facto would follow such a simple rule. For the present econometric analysis on preference heterogeneity it suffices that empirical reaction functions fit the data reasonably well in-sample.[4]

Preference heterogeneity among policy-makers cannot be observed from voting records. In order to detect such heterogeneity, we compare the parameters of alternative specifications of an empirical reaction function. Deviations in the intercept and the slope parameters may give an indication on the existence of heterogeneity in terms of preferences and views on key economic data. We are particularly interested in differences in the preference parameter (the intercept α) across members and across specifications. Differences in the intercept (α) between the aggregate and the corresponding pooled regression can be interpreted as an indication of preference heterogeneity. Related differences in slope parameters are linked to diversity of members' views on the inflation and output forecasts.[5] A further interesting question is whether diversity in monetary policy committees in these countries has an influence on the performance of the central bank in achieving its inflation target. Answering this question would require longer runs of data than are currently available, but this would be an interesting direction for further research.

4.1 REACTION FUNCTIONS FOR THE CEE COUNTRIES

In the present econometric analysis, we estimate aggregate and pooled Taylor-type reaction functions using real-time information published in Inflation Reports such as inflation forecasts and output forecasts. While these data should broadly approximate the information available to policy-makers at the time of the decision, it cannot be excluded that policy-makers take into account other, additional sources of information. Though, within the inflation-targeting strategy policy-makers would normally rely on staff forecasts.

The CEE countries are small, open economies. In a small open economy the inflationary consequences of changes in the exchange rate and implied changes of import prices may be of special relevance. Monetary policy deliberations could also be influenced by changes in the exchange rate. In this case, the Taylor rule should be modified so as to include the exchange rate change as an explanatory variable of the policy rate. Alternatively, the exchange rate can be included as a variable to replace the output gap in the Taylor rule. As suggested by Taylor (2001) preferably a measure of the real exchange rate should be used.

An aggregate (forward-looking) Taylor rule with interest-rate smoothing describes the interest rate decision of the monetary policy committee as a function of the natural rate of interest, the inflation gap and the output gap, and changes in the exchange rate:

[4] One criterion for this is the Taylor principle, which suggests that policy-makers move a (nominal) key interest rate by more than one-for-one with inflation.

[5] A measure for preference heterogeneity that is sometimes used (see Owyang and Ramey, 2004) is the ratio between beta and gamma slope parameters for each member. Ideally, in order to measure individual beta and gamma parameters across members it would be an advantage to use members' individual inflation and output (gap) forecasts in the reaction functions. Like other leading IT central banks, the CEE central banks do not disclose these data. Hence, estimated differences in slope parameters available from the Fixed Effects model may have limited information value, because they only extract information contained in the voting records.

$$i_t = (1-\rho)(\alpha + \beta(\pi_{t+h} - \pi^*) + \gamma y_t + \delta fx_t) + \rho i_{t-1} + \nu_t \quad (1)$$

where *i* is the (nominal) policy rate; π is the inflation forecast; π^* is the target inflation rate; *y* is the output gap; *fx* is the exchange rate change and *t* denotes the time operator and h the horizon of the inflation forecast. With regard to inflation, a horizon of around two years ahead corresponds to the policy horizon which these central banks normally would have in mind (i.e. in the absence of longer lasting shocks such as asset-price shocks). The preference parameter α is the sum of the natural rate of interest and the inflation target which is known for inflation targeting central banks.

Pooled Taylor-type regressions describe the notional interest rate path that would have been the result, if members' individual interest rate votes were simply aggregated. This is an experiment, because it implicitly pretends that averaging votes and not majority voting would be the statutory voting rule of these committees. Moreover, in monetary policy committees the composition of members may change over time owing to staggered contracts and new appointments. When estimating pooled regressions, we take this element into account by specifying an unbalanced panel. Pooled regressions are estimated in the form of Fixed Effects models, Random Effects models and Random Coefficients models. The Fixed Effects model captures the possibility that each committee member has a different preference parameter α_i (i.e. he/she is more hawkish or dovish than the committee mean) and behaves similarly regarding the slope parameters (β and γ). The Random Effects model is similar, but treats differences of individual preference parameters (α_i) as random. The Random Coefficients model treats differences in policy-makers' preferences (α_i) as random but allows for variations in individual slope parameters (β_i and γ_i). Assuming that in inflation targeting central banks members fully share the official inflation target, observing different preferences boils down to differences in the natural rate of interest across members.

The Fixed Effects regression takes the following form:

$$i_{n,t} = (1-\rho)(\alpha_n + \beta(\pi_{t+h} - \pi^*) + \gamma y_t + \delta fx_t) + \rho i_{n,t-1} + \varepsilon_{n,t} \quad (2)$$

and the Random Effects regression has the following representation:

$$i_{n,t} = (1-\rho)((\alpha + \tau_n) + \beta(\pi_{t+h} - \pi^*) + \gamma y_t + \delta fx_t) + \rho i_{n,t-1} + \omega_{n,t} \quad (3)$$

where *n* denotes individual members, α comprises the mean and τ is a random deviation by member. The Random Effects model is used as a benchmark for comparison with the Fixed Effects model when applying the Hausman test. In order to estimate member specific slope coefficients (see Equation 4), a Random Coefficients model is specified. It has the following representation:

$$i_{n,t} = (1-\rho)((\alpha + \tau_n) + \beta_n(\pi_{t+h} - \pi^*) + \gamma_n y_t + \delta_n fx_t) + \rho i_{n,t-1} + \eta_{n,t} \quad (4)$$

The above specifications of the reaction function follow the literature on committees (see e.g. Besley et al., 2008, and Jung, 2011). They incorporate the output gap in levels but not in differences. The output gap and the inflation gap are both stationary variables so that proper identification requires including interest rate inertia. Orphanides (2003 and 2007) includes the output gap both in levels and in differences. This is not needed here, because variables in differences have no impact on the long-term relationship. When modelling policy-makers' reactions to new incoming information, anecdotal evidence suggests that policy-makers would not take changes in the output gap in a systematic manner into account, but at most would occasionally refer to it. In fact, the literature emphasises the high uncertainty surrounding the output gap itself as a useful indicator for monetary policy decision-making.

A comparison of the parameters of (1) with panel regressions (2 to 4) can provide information on three sources of heterogeneity in committees. First, members may share the committee's assessment of the macroeconomic situation, but may be systematically biased regarding the policy response – i.e. be more hawkish or dovish than the mean voter in the committee (see Riboni and Ruge-Murcia, 2008). Preference heterogeneity defined that way implies different intercepts (α). Second, policy-makers may disagree on the response to the inflation forecast or inflation gap (see Berk and Bierut, 2011). This form of heterogeneity would imply different slope coefficients (β). Third, policy-makers may have different views on how to respond to the output gap (see Gerlach-Kristen, 2006) and to the exchange rate. This form

of heterogeneity would imply different slope coefficients (γ, δ). Furthermore, if individual policy-makers are less inertial than the committee when taking interest rate decisions (see Blinder, 1998), this would imply differences in the coefficient ρ.

Heterogeneity in a monetary policy committee may also be attributable to a combination of these factors. For instance, policy-makers may assign different weights to inflation control and output smoothing, given different interpretations of the central bank's mandate. If policy-makers have a different focus on the maintenance of price stability or if the focus changes over time, it would imply that they have a different ratio between inflation control and output smoothing (see Sibert, 2002). The sacrifice ratio can be used to describe whether policy-makers are in a "hawk" or "dove" regime. Owyang and Ramey (2004) suggest to check the ratio σ for (supplementary) indications on policy-makers' preferences for a certain regime or chairmanship.

Furthermore, some heterogeneity that results from factors not modelled in the above function may not be captured by the intercept and slope parameter estimates. First, committee members may distance themselves from the staff forecast for inflation and output (see Kohn, 2008) or there could be strategic forecasting (see Tillman, 2011).[6] Second, other factors may affect the dynamics of committee deliberations, but the reaction function does not model them as separate sources of heterogeneity. Examples include other indicators of the monetary policy stance such as a monetary conditions indicator, different modes of leadership in a monetary policy committee (Blinder and Morgan, 2007) and disagreements among policy-makers on the "true" objective function of monetary policy. Third, other unobservable variables such as tenure and background of policy-makers may explain heterogeneity. Because most empirical studies for monetary policy committees of advanced countries find that these variables do not play a prominent role (see Besley et al., 2008, and Jung, 2011), we do not examine them further here.

Identification between the Fixed Effects and the Random Effects model is checked by means of a Hausman test for correlated random effects. A rejection of the Random Effects model is a first indication for systematic differences in the intercept (i.e. the preference parameter) across committee members, because otherwise the distribution of preferences around the mean would be random. Parameter equality in the aggregate regression and the corresponding pooled regression for a committee is checked by means of Wald-tests. The econometric approach to estimating the committees' reaction functions with real-time data is in the tradition of Orphanides (2001). We check for heteroscedasticity, and where relevant, we apply White's (1980) correction in order to compute heteroscedasticity-consistent standard errors. We also give consideration to the issue that model estimates in dynamic panels with real-time data could suffer from autocorrelation. In a dynamic panel a GMM technique (see Arellano and Bond, 1991) could provide unbiased estimates of the slope coefficients, but its use is not indicated here because the sample with five years of monthly observations is considered to be of sufficient length to be immune to a small sample bias in the time dimension. Orphanides (2001) and Koustas and Lamarche (2010) observe that it is appropriate to use non-linear least square estimation techniques and OLS (as opposed to IV or GMM estimation) when real-time data are used. In the following, results of regressions are obtained from OLS/NLS, pooled OLS for fixed effects and from Generalised Least Squares (GLS) random effects coefficient estimates (applying the Swamy-Arora estimator, for details see Baltagi, 2001).

4.2 EMPIRICAL RESULTS FOR THE MNB AND THE NBP

In the following, we consider two inflation targeting central banks for which voting records and real-time information on economic and financial indicators have been published, the MNB and the NBP. The econometric analysis focuses on the sample 2005 to 2010. For this sample voting records and real-time information on economic and financial indicators are available. At the same time, this sample is unique because it is characterised by pronounced shocks, in particular a strong oil price shock and a massive financial crisis. In most industrial countries, key interest rates were lowered to practically zero in order to address the adverse shock by the financial crisis. Still, the MNB and the NBP succeeded to keep key interest rates safely above zero. This is relevant, because once the zero lower bound restriction gets binding and central banks resort to non-standard policies, it can no longer be taken for granted that a Taylor-type rule is an appropriate

[6] Note that game theory would suggest that organising an interest-rate setting meeting in a two stage process by which policy-makers reveal their preferences could be seen as a way to rule out strategic voting behaviour.

benchmark to analyse interest rate setting behaviour by policy-makers. In this case, analysis would have to be based on other reaction functions including a monetary base rule.

4.2.1 A real-time data base

As a first step of the empirical analysis it is useful to briefly discuss the data requirements. For the present analysis a new real-time data base for key economic and financial indicators and information on policy-makers' votes from published voting records had to be established (see Appendix). The basic data needs for the econometric exercise are the (published) policy rate, members' individual votes in terms of a policy rate, the inflation gap and the output gap, and possibly a proxy for the exchange rate. Data for the policy rate and the exchange rate are available from the central banks' website. Individual (interest rate) votes by committee members can be extracted from the official voting records. In this respect, voting records of the MNB give a clear indication on the desired interest rate level by policy-maker at a certain meeting. In the case of the NBP sometimes votes on two interest rate options follow each other; here the first vote is the proxy for the interest rate preference (see Sirchenko, 2011). We calculate the inflation gap as the difference between the staff inflation forecast (1-2 years ahead) and the official inflation target. We use inflation forecasts which are conditioned on constant interest rates. While this forecast is normally part of the information set that policy-makers observe in real-time, policy-makers may internally also consider forecasts based on market rates or on endogenous monetary policy.[7] When experimenting with forward-looking measures of the output gap, it turned out that these reaction functions did not yield satisfactory results. Therefore, we use the (contemporaneous) real-time output gap measure. As concerns the inflation gap and the output gap, all members are thought to base their vote on the latest staff forecast available at the time of the decision. When estimating the reaction functions the simplifying assumption is made that new information on economic indicators becomes available at the meeting when the inflation report is published. By comparison, for financial indicators such as the interest rate and the exchange rate latest monthly updates are available for each meeting.

An issue receiving some attention in the literature is whether using inflation forecasts in Taylor rules could give rise to endogeneity problems. For example, in strict inflation targeting regimes ex post interest rates may no longer react to changes in inflation developments. This point is more general and could become relevant whenever the inflation forecast at the policy horizon is by intention kept in line with the inflation target or when central banks use the own interest rate to condition their inflation forecast. Though, in the present study the forecast observations are based on the neutral assumption of constant interest rates and not on endogenous monetary policy (MNB since 2011) or market interest rates (NBP using NECMOD). Together with the assumptions made for other variables in the forecasting exercises, this implies that forecast uncertainty is still considerable. Moreover, as suggested by Boivin (2006), we tried alternative forecast horizons that may be different from the policy horizon in order to find out the best specification.

A clarification why we focus on monthly data may be in order here. Basically, the argument is that a switch to the quarterly frequency would imply a loss of information. In pure econometric terms the use of quarterly data in our study would reduce the number of observations to about 20 so that the panel regressions would probably suffer from a Nickel bias. And also from the perspective of the monetary policy process, the use of monthly data is justified. In the committees considered, policy-makers meet at the monthly frequency and get a new set of indicators prior to each meeting but they will normally get new macro forecasts only once a quarter (since 2008 the NBP has published new forecasts only three times a year). There may be changes in policy-makers' assessments in these monthly meetings based on a wide range of new incoming data (not only monetary and financial variables but also survey data on the macro economy). It is plausible to assume that at the meeting policy-makers will have a richer data set at their disposal than simply an inflation forecast. Policy-makers may therefore deviate from the indications of the staff forecast when they meet each month. For example, in the interim meetings for which no new staff forecasts become available, it can be expected that each month members take into account the effects, if any, of changed forecast assumptions such as oil prices and exchange rates for inflation and output. In part, such changes in policy-makers' assessments can be captured by the monthly voting data on individual interest rate preferences. Furthermore, available studies on monetary policy committees for advanced countries use either monthly data or refer to the frequency of the meetings.

[7] For example, since 2011, the MNB computes staff forecasts based on endogenous monetary policy for its deliberations. Similarly, the CNB conditions its staff forecast on their own interest rate forecast without implying a commitment for the central bank to act accordingly.

Before estimating the empirical reaction functions, it may be useful to briefly review some basic time series properties of the data and to check for the existence of cointegration relationships. If well behaved, short-term interest rates should be I(1)-processes, whereas inflation gaps and output gaps should be I(0). Concerning the exchange rate, it may depend on the exchange rate regime. When applying standard unit root tests (ADF-tests, Phillips Perron-tests) to the data, we can confirm that interest rates, individual interest rate preferences, and bilateral exchange rates vis-à-vis the euro are I(1).[8] However, the results for the inflation gaps and output gaps are more borderline, i.e. depending on the test setting and critical significance level somewhere between I(0) and I(1). In fact, it cannot be excluded that these variables are I(1) in the rather short sample considered. Gerlach-Kristen (2003b) and Österholm (2005) suggest that, if data in the Taylor rule are non-stationary, cointegration is a necessary property both for consistent estimation of the parameters of the model and compatibility between the model and the data. They argue that in the absence of cointegration, parameters in Taylor rule regressions are likely to be inconsistently estimated, and caution would be warranted before central bank policy is evaluated using such methods.

In order to address this point, we apply Johansen cointegration tests as rough specification tests. We include alternative pairings of the interest rates (i), inflation gaps ($\pi-\pi^*$), output gaps (y) and (bilateral) euro exchange rates (fx). Compared to other cointegration tests, the Johansen test has the advantage that it reports information about the number of cointegrating vectors (cointegration rank). It is, however, somewhat sensitive to the lag structure and requires longer runs of data to provide robust results. Moreover, we also include bivariate tests between an explanatory variable and the policy

Table 3
Johansen tests for the number of cointegrating vectors

System	Rank r	Trace statistics	95% critical value	Result
		Hungary		
i, ($\pi-\pi^*$)	= 0 ≤ 1	22.30** 3.73	15.49 3.84	One cointegration vector
i, y	= 0 ≤ 1	10.82 1.23	15.49 3.84	No cointegration vector
i, fx	= 0 ≤ 1	13.42 1.76	15.49 3.84	No cointegration vector
i, ($\pi-\pi^*$), y	= 0 ≤ 1 ≤ 2	34.75** 10.84 1.86	29.80 15.49 3.84	One cointegration vector
i, ($\pi-\pi^*$), y, fx	= 0 ≤ 1 ≤ 2 ≤ 3	43.40 23.17 10.70 1.59	47.86 29.80 15.49 3.84	No cointegration vector
		Poland		
i, ($\pi-\pi^*$)	= 0 ≤ 1	17.18** 4.59**	15.49 3.84	Two cointegration vectors
i, y	= 0 ≤ 1	19.06** 5.40**	15.49 3.84	Two cointegration vectors
i, fx	= 0 ≤ 1	17.10** 6.29**	15.49 3.84	Two cointegration vectors
i, ($\pi-\pi^*$), y	= 0 ≤ 1 ≤ 2	58.29** 12.98 5.34	29.80 15.49 3.84	One cointegration vector
i, ($\pi-\pi^*$), fx	= 0 ≤ 1 ≤ 2	26.85 13.93 4.38	29.80 15.49 3.84	No cointegration vector
i, ($\pi-\pi^*$), y, fx	= 0 ≤ 1 ≤ 2 ≤ 3	57.58** 25.10** 9.16 0.49	47.86 29.80 15.49 3.84	Two cointegration vectors

Notes: Johansen test for cointegration rank r with four lags, Poland: 2000:6–2010:11, Hungary: 2005:10–2010:11.
*** denotes significance at the five percent level (eigenvalue statistics provide similar indications).*

[8] For brevity of the analysis, the results of the unit root tests are not reported here, but are available upon request from the authors.

rate (thereby mimicking the classical Engle-Granger cointegration test). Table 3 shows the results from this exercise. For Hungary, the Johansen test is ambiguous, because it indicates one cointegration relationship between the interest rate and the inflation gap but also between the interest rate, the inflation gap and the output gap. Here, bivariate cointegration tests may help further. They indicate that both the output gap and the exchange rate (HUF/EUR) is not a long-run driver of the Hungarian policy rate. Applying similar reasoning for Poland, the Johansen test indicates that the relevant cointegration relationship is between interest rates, the inflation gap and the output gap. Cointegration tests also reject the view that the exchange rate could substitute the output gap in the reaction function (see Siklos and Ábel, 2003). Adding the bilateral exchange rate (ZL/EUR) in levels to the system leads to two cointegration vectors. It seems that the exchange rate plays an independent role which could only be captured within a system.

4.2.2 Empirical reaction functions with interest rate smoothing

We estimate the reaction functions of the two monetary policy committees using Taylor-type rules (equation 1 to 3) with interest rate smoothing. Table 4 shows that as expected these regressions have a high explanatory power and parameters are significant at conventional levels. Slope coefficients are significant with the correct sign. The policy rate reacts positively to an inflationary shock and to shocks that widen the output gap or imply a depreciation of the domestic currency vis-à-vis the euro. A number of interesting results emerge from the estimates.

First, the reaction function for the NBP takes the form observed for other Western European central banks such as the Bank of England (see Besley et al., 2008) and the Sveriges Riksbank (see Jung, 2011). The parameters for the (forward-looking) inflation gap and the (contemporaneous) output gap are significant for the NBP. The coefficient for the exchange rate is not, presumably, because it plays a separate and less systematic role in the deliberations. An issue arises with the inflation gap coefficient (β), which in the aggregate version fully corresponds to the Taylor principle ($\beta>1$), but not for the pooled versions of the regression. This might be an indication of heterogeneity, because it seems to suggest that the committee as a whole follows a classical Taylor rule, whereas some of its members would not. We address this issue further by means of a cluster analysis below. For the MNB the (forward-looking) inflation gap is significant, the coefficient is in line with the Taylor principle, but the output gap is not significant in conjunction with a forward-looking measure of the inflation gap. This finding is, however, in line with the above bivariate cointegration tests and other studies in the literature. Some studies suggest that in Taylor rules for Hungary the output gap is insignificant even when final data and GMM techniques are applied (see e.g. Hidi, 2006 and Mohanty and Klau, 2004). In our sample several proxies of the real effective exchange rate and of bilateral exchange rates vis-à-vis the euro or the US dollar were not significant either. The emphasis in Hungary seems to be on smoothing output volatility in the context of achieving the inflation target. Still, these reaction functions with a zero weight on output stabilisation are capable of capturing the interest-rate channel.

For Hungary, we also checked the sensitivity of the results to the magnitude of the inflation target. When using an alternative inflation target of 4.5%, which may be seen as being closer to an equilibrium value, we obtained comparable results, but the intercept α was no longer significant in the aggregate Taylor rule. Moreover, a significant part of the observed deviation of inflation outcome from the target can be attributed to temporary factors outside the control of the central bank such as VAT increases. On both grounds, we conclude that using the official inflation target in this framework is appropriate. Moreover, the special importance of the exchange-rate channel in real-time decision-making can neither be confirmed for the Polish nor for the Hungarian monetary policy. In line with the above cointegration tests, when adding the exchange rate in levels, it turns out that the overall specification deteriorates in terms of significance of the other variables. This may be related to the observation that the exchange rate may have played a role in the deliberations of these committees but its importance is either related to certain episodes or the information content of the exchange rate is already picked by the inflation gap. Hence, our estimations rely on the interest rate channel as the most prominent channel of monetary policy transmission.

Second, inertia are very important as suggested by the high values of ρ. As is well known, a large part of the interest rate level at time t is explained by the previous interest rate. This is explained by the fact that at a policy meeting in interest rates are either unchanged or changes are made by small amounts of usually 25 to 75 basis points (on rare occasions MNB has made moves in excess of 100 basis points). Moreover, observed differences in the inertia coefficient between aggregate and pooled regression, as confirmed by Wald-tests, support Binder's (1998) notion according to which committees are more inertial than individual policy-makers. Third, for the MNB and the NBP the Hausman test selects the Random Effects model

implying that preference heterogeneity in both committees is not systematic. Fourth, applying Wald-tests to the preference parameter (α) signals the existence of some preference heterogeneity within the NBP, but clearly rejects its existence within the MNB. Applying Wald-tests to the slope coefficients between corresponding aggregate and pooled reaction functions (see shaded rows in Table 4) suggests that diversity in policy-makers' views on the inflation gap is measurable for both the MNB and the NBP. In addition, the test detects diversity in policy-makers' views on the output gap in the case of NBP.

Fifth, using the mid-point of the NBP's inflation target of 2.5% would yield (implied) estimates of the natural (real) rate of interest r* in a range of 0.8% to 1.9% depending on the specification. Brzoza-Brzezina (2006) points out that the natural rate in Poland shows a high variability and crucially depends on the sample. For comparison, during 1998 to 2004, they provide an estimate for the natural real rate of about 4.6 to 5% for Poland. It should be noted that inflation during this period was declining substantially from high levels of about 12%, and since 2004 stabilised at levels close to the inflation target. Moreover, for Hungary, given the official inflation target of 3%, our estimates imply a range of 3.5% to 4% for the natural rate of interest. We are not aware of any study for Hungary that could provide a benchmark for comparison in this respect. Poland and Hungary are both transition economies. Hence, any estimate of the natural rate of interest is expected to be time-varying and sample dependent.

Table 4
Empirical reaction functions with interest rate smoothing

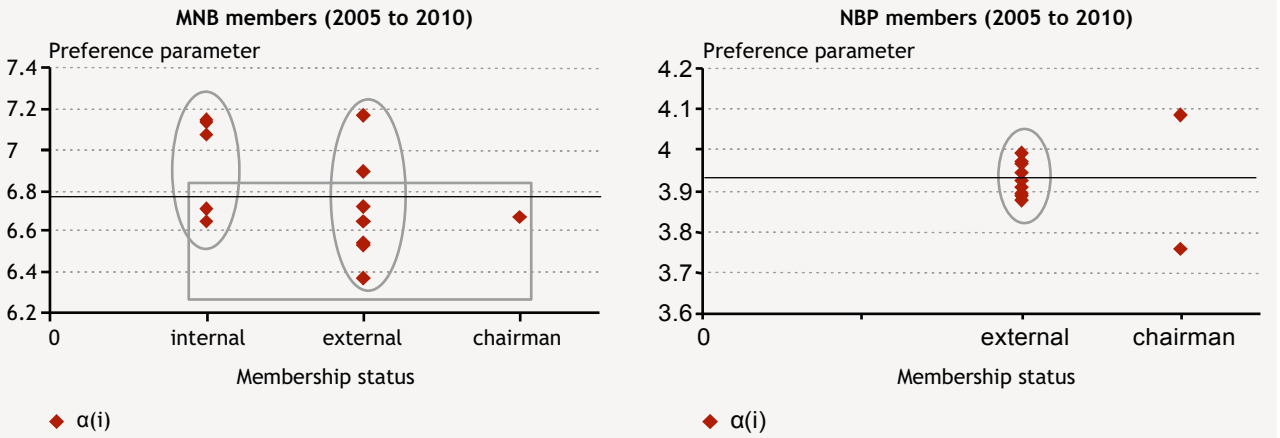
Coefficients Equation	α	β	γ	δ	ρ	Prob.	Adj. R^2	Obs.	Pooled obs.
					Hungary				
Aggregate	6.465 (1.084)	3.392* (1.599)	–	–	0.955* (0.039)		0.92	61	–
Fixed Effects	6.777 (0.315)	1.230 (0.197)	–	–	0.831 (0.021)		0.92	60	590
Random Effects	7.017 (0.155)	1.344* (0.209)	–	–	0.842* (0.020)	0.322	0.92	60	590
					Poland				
Aggregate	3.302* (0.536)	1.193* (0.500)	0.605* (0.235)	–	0.939* (0.026)		0.95	73	–
Fixed Effects	4.361 (0.139)	0.565 (0.093)	0.258 (0.047)	–	0.734 (0.026)		0.90	73	721
Random Effects	4.339* (0.122)	0.515* (0.097)	0.250* (0.051)	–	0.749* (0.025)	0.086	0.88	73	721

*Notes: Standard errors in brackets. Hungary: 2005:11–2010:11; Poland: 2004:1–2010:1. Prob.: Hausman specification test selects the Random Effects model, if the probability exceeds 5% – otherwise the Fixed Effects model is selected. * indicates that Wald tests reject that parameters in the selected (shaded) aggregate and pooled regressions are equal at 5% level.*

4.2.3 Cluster analysis for the MNB and the NBP

A further way to examine the results from the empirical reaction function is to check the clustering of the individual preference parameters (α_i) in the Fixed Effects (FE) model and of the slope parameters in the Random Coefficients model (RC). Such type of analysis could give clues on whether there is scope for the government to actively influence the composition of a monetary policy committee with political business cycle considerations in mind whenever it has to decide on new appointments. For the UK, Hix, Høland and Vivyan (2010) use a "dove-hawk" scale for the Bank of England's MPC and reject the idea that the British government seeks to appoint more dovish members prior to elections. We use a cluster analysis as a robustness check in order to find out whether a link exists between the preference of committee members and their role in the committee. According to the literature, it would be expected that internal members are more hawkish and external members are more dovish. In a first step, we study the distribution of the preference parameter from the Fixed Effects model (1). In a second step, we extract the distribution of the slope parameter(s) from the Random Coefficients model (4). Because individual forecasts by members of inflation and output are not available, these slope parameters only extract information on diversity from the voting records.

Chart 3
Preference clusters of committee members: The MNB versus the NBP



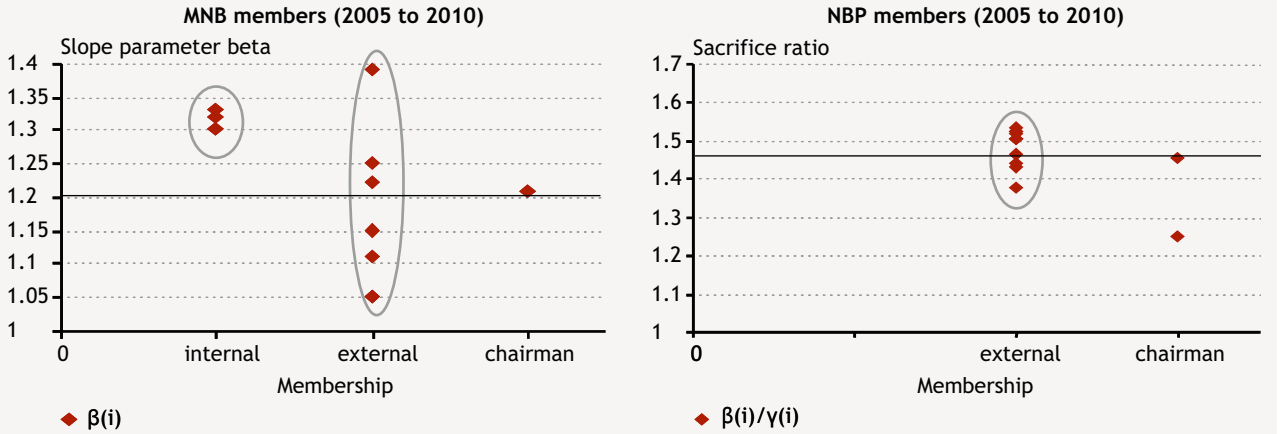
Note: Estimates from Fixed Effects model. Membership takes different values. A solid, horizontal line shows the average preference parameter for these members. Members with short observation periods have been excluded from the panel. Note: deviations of the mean value of α from the values reported in Table 4 are due to differences in the sample used for the estimations.

Chart 3 shows a scatter plot of the individual parameters α_i (obtained from the FE model) for the MNB and the NBP grouped according to different modes of membership (internal member, external member, chairman). This exercise is a robustness check, and it goes beyond the indications of the Hausman test according to which differences in the intercept should be random. For the MNB, in line with what the literature finds for the Bank of England's MPC, the different width of the parameter distribution and the position relative to the committee mean suggest that internal members may be on average more hawkish than the external members. This would explain why in 2005 the Hungarian government may have had an incentive to enlarge the MPC by adding external members. At the same time, external members may be hawkish or dovish depending on the individual member so that it is not on safe grounds to conclude that preferences of internal members are always more hawkish than those of external members. Interestingly, chairman Simor takes a position in the middle of the committee. This is a natural position for a chairman who assumes the role of a consensus builder in the Monetary Council. Finally, it is conceivable that a third cluster exists across different modes of memberships with a preference structure that is more dovish than the committee mean and where membership is not the explanatory factor. By contrast, in the case of the NBP, where all members except the chairman are external members, no distinction along the above lines can be made. Here, members' preferences cluster closely around the committee's mean with the exception of the chairman's preference which takes a corner position (Balcerowicz at the hawkish end, Skrzypek at the dovish end). It may explain the observation that aggregate and pooled preference parameters are different even though deviations are found to be random. In practical terms, this setting may imply that whenever the chairman assumes an extreme position with regard to an interest rate proposal other committee members may not follow him or dissent. In press reports for Poland, the two chairmen Balcerowicz and Skrzypek are characterized as being on the opposite scale of a hawk-dove classification. The first one dissented several times in favor of tighter interest rates, whereas the latter one always dissented for easing of rates (see Chart 2). The study by Kotlowski (2005) confirms this notion by providing evidence covering the period 2004 to 2005 which suggests that chairman Balcerowicz was among the most hawkish members of the Monetary Policy Council.

In order to check how different views about the economic outlook impact on interest rate setting, we make a further experiment for Hungary and Poland and use the test results from the Random Coefficients model. For the MNB our comparisons of members' responses to new economic data have to be based on the slopes (β_i) which measure the response to changes in the expected inflation gap. We cannot compute sacrifice ratios as in the case of Poland, because for Hungary the output gap is not significant. For the NBP the individual slope parameter distributions (β_i/γ_i) provide individual sacrifice ratios (σ_i) that allow us to check whether members respond more or less aggressively to changes in the inflation and output gap (see Sibert, 2002; Owyang and Ramey, 2004).

For Hungary anecdotal evidence suggests that some members have had difficulties to accept the inflation targeting framework and have continued to support other goals, thereby being perceived on the more dovish side when there are changes in the inflation gap. We look into the distribution of the slope parameter β_i across committee members which are

Chart 4
Clusters of MNB and NBP members to the sacrifice ratio and the inflation gap respectively



Notes: Estimates from the Random Coefficients model. A solid, horizontal line shows the average parameter for these members. Members with short observation periods have been excluded from the panel. Note: deviations of the mean value of slope parameters from the values reported in Table 4 are due to differences in the sample used for the estimations.

obtained from the Random Coefficients model. This offers a further check for robustness and allows evaluating the above results. The reaction of members to the inflation gap provides an indication on how aggressive they respond to inflationary shocks. In terms of the reaction to the inflation gap, Chart 4 (LHS) confirms that somewhat different reaction patterns depending on the membership status can be observed. For the MNB, as illustrated by the two clusters, internal members tend to react more aggressively to the inflation gap than external members. The chairman takes a neutral position in the committee. Interestingly, all members individually respect the Taylor principle ($\beta > 1$). For the NBP anecdotal evidence suggests, that chairman Balcerowicz stood out as a very hawkish member, whereas chairman Skrzypek was often referred to as a very dovish member. Chart 4 (RHS) shows that chairman Balcerowicz takes a neutral position close to the mean, i.e. he reacts similar to the other members to new incoming economic data, whereas also here chairman Skrzypek is identified as the most dovish member by far. All other (external) members are close and evenly distributed around the mean, with half of them on the hawkish side and half of them on the dovish side.

5 Conclusions

In this paper we have estimated empirical reaction functions for the Monetary Council of the central bank of Hungary and the Monetary Policy Council of the National Bank of Poland to study preference heterogeneity in these policy committees. We are aware that detecting diversity in monetary policy committees may be hampered by several factors that are linked to the confidential nature of the policy-making process. That is why we pursue an indirect measurement using empirical reaction functions for the monetary policy committees in two of the largest CEE countries during the period 2005–2010. Moreover, the debate on rules versus discretion has clarified that, when setting interest rates, policy-makers consider various aspects that cannot be captured by means of a simple rule. For example, they typically consult a broad range of indicators and a suite of models in their assessments of inflationary risks. Hence, when estimating empirical reaction functions, we do not assume that policy-makers de facto would follow such a simple rule. The present comparison of the intercept and slope parameters from aggregate and pooled Taylor-type reaction functions estimated using real-time information on economic and financial indicators and voting records allows for a structural interpretation of information on members' preferences, as contained in voting records. For both committees the parameter of the inflation gap in the estimated reaction functions is significant and has the expected sign. In case of Poland the output gap is also significant, while for Hungary, in line with the literature, it is not. Moreover, the parameter for the exchange rate is in both cases not significant, thereby rejecting a separate and systematic effect coming from that variable. These findings are supported by separate Johansen cointegration tests.

Applying these empirical reaction functions, the paper suggests that like for other central banks in the Western hemisphere, diversity across policy-makers is an important feature of voting by monetary policy committees in inflation-targeting countries of the CEE. Unlike for monetary policy committees of advanced economies (see Besley et al., 2008, and Jung, 2011), we find preference heterogeneity to be random for both the members of the Polish Monetary Policy Council and those of the Monetary Council of the MNB. Then, by means of a cluster analysis of members' individual preference parameters we show that in both committees internal and external members may vote differently. The MNB case illustrates that internal and external members may mainly differ in terms of their reaction to changes in the economic outlook. By and large, internal members react more aggressively in response to changes in the inflation gap than external members. In this case, the chairman takes a neutral position in the committee, which is a natural position for a chairman who assumes the role of a consensus builder. The NBP is an example of a committee with different preferences between the chairman (i.e. the only internal member) and external members. Members' preferences cluster closely around the committee mean with the exception of the chairman's preference which takes a corner position (Balcerowicz at the hawkish end, Skrzypek at the dovish end). This may imply that whenever the chairman assumes an extreme position with regard to interest rate setting the other committee members may not follow him and dissent. Finally, a possible direction for further research would be to assess the question whether observed preference heterogeneity in these committees influences the performance of the central bank in achieving its inflation target.

Appendix

Voting records and real-time data for Hungary are from the bank's website: http://english.mnb.hu/Statisztika and http://english.mnb.hu/Monetaris_politika/decision-making/voting-records-of-the-mc-members. Real-time data for the National Bank of Poland are from the bank's website: http://www.nbp.pl/homen.aspx?c=/ascx/subgen.ascx&navid=5072.

Table A.1
Database and sources

	Hungary	Poland
Voting records (interest rate preferences)	Extracted from MNB minutes	Extracted from NBP inflation reports and based on Sirchenko (2011)
Inflation	Central Statistical Office	Central Statistical Office
Inflation forecast	MNB inflation reports	NBP inflation reports
Output gap (actual outcome)	Own estimates based on Central Statistical Office	NBP inflation reports since 2007, OECD measure for period before
Output gap (real-time)	Recursive estimates based on real-time information published by Central Statistical Office and MNB inflation reports, alternatively the OECD measure was used	Reported in NBP inflation reports since 2007, a real-time OECD measure is used for the periods before
Exchange rate (real-time)	MNB (available monthly). Several measures were used (HUF/EUR, HUF/USD, real effective exchange rate)	NBP (available monthly). Several measures were used (ZL/EUR, ZL/USD, real effective exchange rate)
Policy rate	MNB	NBP

References

Arellano, M., Bond, S. (1991): Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies,* 58, pp. 277–297.

Baltagi, B. H. (2001): *Econometric Analysis of Panel Data, second ed.,* John Wiley and Sons, West Sussex.

Bank for International Settlements (2008): Monetary policy decisions: preparing the inputs and communicating the outcome. *BIS Papers,* No. 37, BIS, Basle.

Bank for International Settlements (2009): Issues in the Governance of Central Banks. *Report of the BIS Central Bank Governance Group,* BIS, Basle.

Berk, J. M., Bierut, B. (2011): Communication in Monetary Policy Committees. *European Journal of Political Economy,* 27 (4), pp. 791–801.

Berk, J. M., Bierut, B., Meade, E. (2010): The dynamic voting patterns of the Bank of England's MPC. *DNB Working Paper,* No. 261, September.

Besley, T., Meads, N., Surico, P. (2008): Insiders versus Outsiders in Monetary Policymaking. *American Economic Review,* 98, pp. 218–223.

Bikhchandani, S., Hirshleifer, D., Welch, I. (1998): Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades. *Journal of Economic Perspectives,* 12 (3), pp. 151–170.

Blinder, A. (1998): *Central Banking in Theory and Practice,* MIT Press, Cambridge.

Blinder, A. (2004): *The Quiet Revolution: Central Banking Goes Modern,* Yale University Press, New Haven.

Blinder, A. (2007): Monetary policy by committee: why and how? *European Journal of Political Economy,* 23 (1), pp. 106–123.

Blinder, A., Ehrmann, M., Fratzscher, M., de Haan, J., Jansen, D.-J. (2008): Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence. *Journal of Economic Literature,* 46, pp. 910–945.

Blinder, A., Morgan, J. (2007): Leadership in Groups: A Monetary Policy Experiment. *CEPS Working Paper,* No. 151.

Boivin, J. (2006): Has U.S. monetary policy changed? Evidence from drifting coefficients and real-time data. *Journal of Money, Credit and Banking,* 38, pp. 1149–1173.

Brito, R. D., Bystedt, B. (2010): Inflation targeting in emerging economies: Panel evidence, *Journal of Development Economics,* 91, pp. 198–210.

Brzoza-Brzezina, M. (2006): The information content of the neutral rate of interest. *Economics of Transition,* 14 (2), pp. 391–412.

Chappell, H. W. Jr., McGregor, R. R., Vermilyea, T. A. (2008): Regional Economic Conditions and Monetary Policy. *European Journal of Political Economy,* 24, pp. 283–293.

Csajbók, A. (2008): The use of staff policy recommendations in central banks. *MNB Working Paper,* No. 2008/4.

Csermely, Á. (2006): Inflation Targeting in Hungary. *Hungarian Economic Review,* December, pp. 1058–1079.

Dincer, N., Eichengreen, B. (2007): Central Bank Transparency: Where, Why and What Effects? *NBER Working Paper,* No. 13003.

Dincer, N., Eichengreen, B. (2009): Central Bank Transparency: Causes, Consequences and Updates, *NBER Working Paper,* No. 14791.

Eijffinger, S. C. W., Geraats, P. (2006): How transparent are central banks? *European Journal of Political Economy,* 22 (1), pp. 1–21.

Endrész, M., Krekó, J. (2010): The role of foreign currency lending in the impact of the exchange rate on the real economy. *MNB Bulletin,* March 2010, pp. 29–38.

Erhart, S. Vasquez-Paz, J.-L. (2007): Optimal Monetary Policy Committee Size: Theory and cross-country evidence. *MNB Working paper,* No. 2007/6.

Friedman, M. (1960): *A Program for Monetary Stability,* Fordham University Press, New York.

Gerlach-Kristen, P. (2003a): Insiders and Outsiders at the Bank of England. Central Banking 14, pp. 96–102.

Gerlach-Kristen, P. (2003b): Interest rate reaction functions and the Taylor rule in the Euro Area, *ECB Working Paper,* No. 258.

Gerlach-Kristen, P. (2006): Monetary Policy Committees and Interest Rate Setting. *European Economic Review,* 50, pp. 487–507.

Gerlach-Kristen, P. (2009): Outsiders at the Bank of England's MPC. *Journal of Money, Credit and Banking,* 41 (6), pp. 1099–1115.

Gonçalves, C. E. and Salles. J. M. (2008): Inflation Targeting in Emerging Economies: What Do the Data Say? *Journal of Development Economics,* 85, pp. 312–18.

Hidi, J. (2006): Estimating the reaction function for Hungarian monetary policy. *Hungarian Economic Review,* 53, pp. 1178–1199.

Hix, S., Høyland, B., Vivyan, N. (2010): From doves to hawks: A spatial analysis of voting in the Monetary Policy Committee of the Bank of England. *European Journal of Political Research,* 49, pp. 731–758.

Horváth, R., Smidková, K., Zápal, J. (2010): Central bank's voting records and future policy. *Czech National Bank Working paper series,* No. 11/2010.

Jung, A. (2011): An International Comparison of Voting by Committees. *ECB Working paper,* No. 1383.

Jung, A., Mongelli, F. P., Moutot, P. (2010): How are the Eurosystem's Monetary Policy Decisions Prepared? A Roadmap. *Journal of Common Market Studies,* 48, pp. 319–345.

Kohn, D. L. (2008): *Expertise and Macroeconomic Policy, Comments on Insiders versus Outsiders in Monetary Policymaking by Timothy Besley, Neil Meads, and Paolo Surico. Remarks at the Meeting of the American Economic Association,* New Orleans, Louisiana, 4 January 2008.

Kotlowski, J. (2005): Reaction functions of the Polish central bankers. A logit approach. Warsaw School of Economics, *Department of Applied Econometrics Working Paper,* No. 1-05.

Koustas, Z., Lamarche, J.-F. (2010): Estimation of a nonlinear Taylor rule using real-time U.S. data. *Brock University Working Papers,* No. 1005.

Lin, S., Ye, H. (2009): Does inflation targeting make a difference in developing countries? *Journal of Development Economics,* 89 (1), pp. 118–123.

Magyar Nemzeti Bank (2011): *Quarterly Report on Inflation,* March, Budapest.

McCracken, M. (2010): Disagreement at the FOMC: The Dissenting Votes Are Just Part of the Story. *Federal Reserve Bank of St. Louis The Regional Economist,* October 2010, pp. 10–16.

Meade, E. (2005): The FOMC: Preferences, Voting, and Consensus. *Fed St. Louis Review,* 87 (2), pp. 93–101.

Meade, E., Sheets, N. (2005): Regional Influences on FOMC Voting Patterns. *Journal of Money, Credit, and Banking,* 37, pp. 661–677.

Mihov, I., Sibert, A. (2006): Credibility and Flexibility with Independent Monetary Policy Committees. *Journal of Money, Credit, and Banking,* 38 (1), pp. 23–46.

Mohanty, M. S., Klau, M. (2004): Monetary policy rules in emerging market economies: issues and evidence. *BIS Working Papers,* No. 149.

National Bank of Poland (2003): *Monetary Policy Strategy beyond 2003,* NBP, Warsaw.

National Bank of Poland (1998): *Medium-term Strategy of Monetary Policy* (1998–2003), NBP, Warsaw.

Orphanides, A. (2007): Taylor Rules. *Federal Reserve Board, Finance and Economics Discussion Series,* No. 2007-18.

Orphanides, A. (2003): Historical Monetary Policy Analysis and the Taylor Rule. *Journal of Monetary Economics,* 50, pp. 983–1022.

Orphanides, A. (2001): Monetary Policy Rules based on Real-Time Data. *American Economic Review,* 91, pp. 964–985.

Österholm, P. (2005): The Taylor Rule: A Spurious Regression? *Bulletin of Economic Research,* 57, pp. 217–247.

Owyang, M. T., Ramey, G. (2004): Regime Switching and Monetary Policy Measurement. *Journal of Monetary Economics,* 51, pp. 1577–1597.

Riboni, A., Ruge-Murcia, F. (2008): Preference Heterogeneity in Monetary Policy Committees. *International Journal of Central Banking,* 4, pp. 213–233.

Sibert, A. (2002): Monetary Policy with Uncertain Central Bank Preferences. *European Economic Review,* 46, pp. 1093–1109.

Siklos, P. L., Ábel, I. (2003): Is Hungary ready for inflation targeting? *Economic Systems,* 66, pp. 1–25.

Sirchenko, A. (2011): Policymakers' votes and predictability of monetary policy. *European University Institute Working paper* No. ECO 2011/05.

Spencer, C. (2006): Reaction Functions of Bank of England MPC Members: Insiders versus Outsiders. *University of Surrey Discussion Paper,* 06/06.

Taylor, J. B. (1993): Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy,* 39, pp. 195–214.

Taylor, J. B. (2001): The Role of the Exchange Rate in Monetary-Policy Rules. *American Economic Review,* 91 (2), pp. 263–267.

Tillman, P. (2011): Strategic forecasting on the FOMC. *European Journal of Political Economy,* 27 (3), pp. 547–553.

Tootell, G. (1991): Are District Presidents More Conservative than Board Governors? *New England Economic Review,* September, pp. 3–12.

Tóth, M. (2006): The role of transparency in central bank strategy. *Hungarian Economic Review,* December, pp. 1080–1100.

White, H. (1980): A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity. *Econometrica,* 48 (4), pp. 817–838.

MNB Working Papers 2012/2

Voting by monetary policy committees: evidence from the CEE inflation-targeting countries

Print: D-Plus

H–1037 Budapest, Csillaghegyi út 19–21.