An international comparison of voting by committees

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Keywords: Monetary policy committee, Taylor rule, collective decision-making, voting behavior, pooled regressions, heterogeneous preferences.

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Abstract

This paper provides new empirical evidence on policymakers’ voting patterns on interest rates. Applying (pooled) Taylor-type rules and using real-time information available from published inflation reports and voting records, the paper tests for heterogeneity among committee members in three monetary policy committees: the FOMC, the Bank of England’s MPC and the Riksbank’s Executive Board. Unconstrained reaction functions show that in all three committees some diversity of views on the inflation and economic outlook is present. Constrained reaction functions find that preference heterogeneity in all three committees is random and preference distributions in all three committees are fairly symmetric around the respective mean.

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1. INTRODUCTION

In the deliberations of monetary policy committees, policymakers may disagree on what constitutes the most appropriate policy response given circumstances. Several authors have analyzed the monetary policy process from a theoretical perspective or have provided case studies. Examples include Blinder, Ehrmann, Fratzscher, and de Haan (2008), Gerlach-Kristen (2006), Meyer (2004), Moutot, Jung, and Mongelli (2008) and Sibert (2002). Others have provided quantitative evidence mostly focusing on the FOMC and the Bank of England’s MPC. Research by Chappell, Havrilesky and McGregor (1997), Meade and Sheets (2002, 2005), Besley, Meads and Surico (2008), Bhattacharjee and Holly (2006), Riboni and Ruge-Murcia (2008, 2010) suggests that voting by monetary policy committees is characterized by considerable heterogeneity among policymakers. This work has contributed to a better understanding of the dynamics in monetary policy committees.

The present paper aims to provide new empirical evidence on policymakers’ voting patterns on interest rates. It is related to a small, but growing, literature that estimates reaction functions of members of monetary policy committees. The paper first reviews a host of factors that may explain why members in monetary policy committees may have disperse views on the policy rate. It uses a new real-time data base for key economic indicators and information on policymakers’ votes from published voting records. Then it tests for the existence of heterogeneity among policymakers in three monetary policy committees: the FOMC, the Bank of England’s MPC, and the Riksbank’s Executive Board. Unconstrained reaction functions show that in all three committees some diversity of views on the inflation and economic outlook is present. Constrained reaction functions find that preference heterogeneity in all three committees is random and preference distributions in all three committees are fairly symmetric around the respective mean.

The paper is organized as follows. Section 2 explains why heterogeneity is an important element of the monetary policy process involving committees. Section 3 provides a descriptive analysis of dispersion in using information contained in committees’ voting records. Section 4 uses pooled Taylor-type rules to analyse diversity evident from policymakers’ voting records. It compares evidence for three committees: the FOMC, the MPC and the Riksbank’s Executive Board. Section 5 concludes.
2. HETEROGENEITY IN THE MONETARY POLICY PROCESS

Decision-making by monetary policy committees can be described as a group decision-making process under uncertainty. Brainard (1967) compares the task of a monetary policymaker with a risk manager who aims at robust decisions. In committees, members evaluate alternative policy options, and face different sources of uncertainty. They individually express their views on what constitutes the best policy response given circumstances, and vote on the policy options before taking the decision. Blinder (2004) characterizes monetary policy setting by committees as a “quiet revolution” in central banking. Involving a committee in monetary policy decisions reduces the influence of a single policymaker on the decision, but strengthens the democratic process.

Heterogeneity in a monetary policy committee is related to different skills and backgrounds and to different preferences of its members. A survey by the Bank for International Settlements (2009) finds that interactions in monetary policy committees are shaped by internal disagreements among policymakers on the economic outlook and the best policy response. Several authors emphasise the beneficial effects of diverse views in monetary policy committees (see Blinder et al. 2008). Federal Reserve chairman Bernanke (2007) suggests that: “Diversity of views drives the Committee to adopt an eclectic approach and thus serves to limit the risk that a single viewpoint or analytical framework might become unduly dominant.”

Collective and individual factors may influence committee decisions on monetary policy. Discussions in committees require considerable staff input. Information by staff is normally accessible by all committee members, and represents information common to all members. In committee interactions asymmetries may still arise, because members are different. For example they have different professional backgrounds, skills and interest rate preferences. Blinder (2004) mentions different abilities to process evidence presented to them in a meeting. Information asymmetries also arise whenever members have “private” information which they do not share with their peers. On account of these factors, members’ preferences and understanding of the working of the monetary policy transmission mechanism can differ even though they share a common goal.

Monetary policy committees meet frequently to discuss the economic outlook and its implications for
the monetary policy stance (see Table 1). The standard outcome of the meeting is a monetary policy decision which is either an unchanged monetary policy stance or an adjustment of policy rates. Prior to the meeting, members of the committee gather information relevant for the policy decision. At policy meetings, members share the available information and exchange views about the economic outlook, thereby aiming at the best possible monetary policy response given circumstances. Learning among peers has benefits is part of the committee interaction and contributes to reducing data and model uncertainty across policymakers. A condition for effective learning is that members are cooperative and communicate with each other. Sibert (2002) suggests that, when the same members meet regularly “groupthink” can occur and hinder the learning process. Groupthink implies that individual members have an incentive to hide their disagreement, thereby making it impossible to distinguish between individual and collective views of committee members.

*** insert TABLE 1 about here ***

Most committees keep their internal deliberations secret or publish them in an (anonymous) summary form only after intense redrafting. Blinder et al. (2008) attribute differences in disclosing policymakers’ views to different consensus traditions in committees. For example, Kohn (2008) suggests that FOMC members prefer to emphasise consensus and downplay diversity when communicating monetary policy decisions. Issing (2005) observes that the mode of accountability is another important factor. Most monetary policy committees are collectively accountable to the public, and provide only information on the thinking of the committee as a whole. Only few committees emphasise the individual accountability of its members (Bank of England’s MPC, Swedish Riksbank’s Executive Board).

A march towards greater transparency in monetary policy has not changed a widely shared reluctance among policymakers to reveal their individual preferences on policy rates. Therefore, central bank watchers often have difficulties to observe the full diversity of policymakers’ views expressed in committee deliberations. It is widespread practice to map members of a committee in a “hawk – dove” dimension. By contrast, King (2010) suggests that this notion may not be an appropriate reflection of the internal decision-making process in a committee: “I am neither hawk nor dove. Everyone on the

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2 Most central bank statutes foresee that extraordinary meetings are scheduled should circumstances demand it (e.g. when responding to a financial crisis).
committee votes according to his or her judgement of the outlook of the economy.”

Many policymakers think that external disagreements can be counterproductive as they may create uncertainty in financial markets and thereby raise market volatility. Some fear that publication of such information could hinder a free exchange of views at the meeting. Others have incentives to avoid confrontations with the media. Career concerns or concerns regarding their personal independence sometimes also play a role. Some central banks publish (attributed) voting records with detailed information on agreement and dissent by member. Voting records contain quantitative information on the occurrence of disperse views by policymakers in committees. The balance of votes reports dissent and agreement on the interest rate decision by members. Such voting records give the public a sense on diversity in the committee after each meeting. Examples of central banks that publish attributed voting records are the Federal Reserve, the Bank of England, and the Swedish Riksbank.3

Statistics on dissenting are not unbiased indicators of policy preferences (McCracken 2010 and Havrilesky and Gildea 1991). In general, voting records tend to understate differences in views among members expressed at the meeting. For example, the Fed’s “bias statement” gives policymakers a possibility to signal dissent in a non-attributed manner. Concessions to members when drafting the bias statement reduce members’ incentive to dissent. Chappell, McGregor, and Vermilyea (2007) find evidence for this behavior during the period 1987 to 1992, but not for the period 1993 to 1999.

Better sources on diversity can be extracted from transcripts and minutes.4 They provide more detailed information on diversity of views in the committee, but are only published with considerable delays of some years. For instance, the FOMC publishes transcripts after about 5 years, the ECB after 16 years, and the Deutsche Bundesbank after 30 years. Moreover, theses sources leave ample scope for guesswork when mapping qualitative information into quantitative information. Against the above, most researchers have used (attributed) voting records for the analysis of preference heterogeneity in a monetary policy committee.

3 By contrast, in the case of the Reserve Bank of New Zealand and the Bank of Israel, the Governor is also the sole independent decision maker, so there is no formal voting record.

4 Since the October 2007 meeting, FOMC minutes include four times a year a new section on diversity of participants’ views on forecasts. The information provided is not attributed to individual members, but only shows
3. A DESCRIPTIVE ANALYSIS OF COMMITTEES’ VOTING RECORDS

FOMC voting records have been analyzed extensively by researchers and are regularly scrutinized by Fed watchers. In a 30 year time span (1978-2008), 200 dissents were voiced in support of tighter and 125 dissents in support of looser policy (see Chappell, Havrilesky, and McGregor 1997). Policymakers dissented in both directions (easing and tightening bias). The intensity by which FOMC policymakers have dissented is time-varying. Meade and Sheets (2006) observe a peak in FOMC dissenting during the late 1970s and early 1980s. Paul Volcker’s chairmanship turned out to be an era associated with an unusually high degree of dispersion. The question how aggressive monetary policy should be tightened to bring down high inflation to more moderate levels in view of strong divergences in regional unemployment rates attracted substantial disagreement.

In a federal central banking system, policymakers from the regional offices are more likely to cast dissenting votes for tighter than for easier monetary policy. Meade and Sheets (2002, 2005) report empirical evidence in support of the “regional bias hypothesis”. FOMC policymakers do take into account regional unemployment rates when deciding on interest rates, but policymakers at the centre find these developments more important than those in the periphery. Another strand of the literature (see Gerlach-Kristen 2006, and Bhattacharjee and Holly 2006, and Fujiiki 2005) suggests that in committees comprising “internal” and “external” members, “external” members more often show disagreement with the policy decision. The voting behaviour of the Riksbank’s Executive Board provides a counterexample. This committee comprises only “internal” members, but all members are active dissenters (see Ekici 2009).

Table 1 (last item) reports an aggregate activity measure as a crude proxy to measure differences in the consensus mode across committees. It relates the number of dissents to total votes. The different values of the measure are a first indication that diversity may vary across policy committees. But, this aggregate measure is a sample average and does not account for the direction of dissent. Figure 1 shows the balance of votes for three monetary policy committees (FOMC, MPC, Riksbank’s Executive Board). In the period 1998-2008, FOMC members have taken decisions in a highly consensual manner.

the distribution in the committee.
Dissenting was infrequent, and the dispersion of Board members’ and regional presidents’ votes was low.\textsuperscript{5} In almost all meetings a broad majority of members or all members supported the chairman’s proposal on interest rates. For comparison, monetary policy committees of other central banks - such as the Bank of England and Swedish Riksbank - have taken their monetary policy decisions in a less consensual manner as indicated by a higher number of members casting a dissent throughout the whole sample. These voting records show that typically a majority of members agreed with the policy proposal. Because a majority of members supported the policy proposal, the chairman of the committee seldom exercised a casting vote.

*** insert FIGURE 1 about here ***

Split interest rate decisions are another indicator for the degree of dispersion in a committee. Episodes of split interest rates were absent for the FOMC over the past decade, whereas for other committees such episodes were rare (see Riboni and Ruge-Murcia 2010, p. 401). The following examples illustrate the point. First, the Bank of England’s MPC recorded about 10 occasions when a thin 5:4 majority supported the interest rate proposal. Governor Mervyn King “famously” dissented, and was outvoted on three occasions (namely August 2005, June 2007, and again in August 2009). Second, the Executive Board of the Riksbank had a tie on four occasions (namely 5 July 2001, 1 December 2005, 3 May 2007 and 3 September 2008), and the Governor’s casting vote determined the outcome.

For the FOMC, Chappell, Havrilesky and McGregor (1997) provide evidence of significant diversity during the 1970s and the 1980s both in terms of views and preferences. A host of factors seems to have contributed to more consensual voting over past decades. The “new consensus” on US monetary policy (Goodfriend 2007) which includes developments such as increased transparency on the monetary policy process, a strong ability of the chairman to forge consensus in the committee (under chairmen Greenspan and Bernanke, see Meyer 2004, p. 40), improvements in the sharing of information among policymakers, and the popularity of the “Taylor-rule” as a tool for policy evaluation.

\textsuperscript{5} Transcripts show that FOMC members on occasion expressed more diversity of views during the internal assessment. Policymakers’ published forecast ranges have widened and narrowed. They imply that views in the committee on occasion have been more diverse than indicated by the balance of votes.
4. AN ECONOMETRIC ANALYSIS OF DIVERSITY IN COMMITTEES

The descriptive analysis of attributed voting records in the previous section does not identify the sources for disagreement among members of a monetary policy committee. Econometric tools can help to extract such information from real-time data. This section provide econometric results from Taylor-type reaction functions for the FOMC, the MPC and the Riksbank’s Executive Board. It follows and refines the approach by Besley et al. (2008) for the MPC to detect diversity in monetary policy committees (see also Riboni and Ruge-Murcia 2008). A (pooled) Taylor-rule provides for a structural interpretation of the parameters. Differences in reaction parameters across monetary policy committees and across time in individual and aggregate Taylor-type rules can provide an indication about the sources of diversity among committee members.

The approach has known limitations. First, policymakers do not base their decisions on the estimated rule. They refer to a much broader set of indicators when taking decisions including money and credit aggregates and exchange rates. Second, policymakers may disagree with how a simple policy rule models the transmission mechanism. For instance, channels of monetary policy transmission other than the interest rate channel are important in a financial crisis episode. Third, policymakers may be more averse to deflationary than to inflationary shocks so that the implicit assumption of a symmetric loss function may be violated (see Kilian and Manganelli 2007).

4.1 Testing for heterogeneity in monetary policy committees

This section uses Taylor rules with real-time data, interest rate smoothing and a known numerical value that denotes the committees understanding of its primary objective – normally price stability (see Svensson 1997, and Issing 2005). This value enters directly into the calculation of the inflation gap. When estimating the reaction functions, we use the inflation gap derived from a two-year ahead inflation forecast ($\pi_{t+24}$) at time t and the (contemporaneous) output gap. We check for robustness using specifications with more forward-looking output gaps. However, when one- and two-year ahead measures are used, test results show that the estimated parameter for the output gap deteriorate both in terms of significance and correct sign.

An aggregate Taylor rule with interest-rate smoothing explaining the final outcome of the committee’s

$$i_t = (1 - \rho)(\alpha + \beta(\pi_{t+24} - \pi^*) + \gamma y_t) + \rho i_{t-1} + v_t$$
deliberation is given by: \[ i \] \[ \text{(1)} \]

where i is the (nominal) policy rate; \( \pi \) is the inflation forecast; \( \pi^* \) is the target inflation rate; \( y \) is the output gap; and \( t \) denotes the time operator.

Pooled regressions with fixed and random effects are then estimated. Pooled regressions with fixed effects capture the possibility that each committee member has a different interest rate preference (i.e. be more “hawkish” or “dovish” than the mean). The fixed effects regression takes the following form:

\[ i_{n,t} = (1 - \rho_n)(\alpha_n + \beta_n(\pi_{t>24} - \pi^*) + \gamma_n y_t) + \rho_n i_{n,t-1} + \epsilon_{n,t} \] \[ \text{(2)} \]

where \( n \) denotes individual members.

The random effects model treats differences in policymakers’ preferences (\( \alpha \)) as random, thereby in principle allowing for variation in slope parameters (\( \beta, \gamma \)). The random effects regression has the following representation:

\[ i_{n,t} = (1 - \rho_n)(\alpha + \beta_n(\pi_{t>24} - \pi^*) + \gamma_n y_t) + \rho_n i_{n,t-1} + \omega_{n,t} \] \[ \text{(3)} \]

We specify an unbalanced panel, thereby accounting for changes in the composition of policy committees owing to staggered contracts and new appointments. Data for the individual (interest rate) preferences by committee members as available from the voting records are included in the individual or pooled reaction functions. As concerns the inflation gap and the output gap, all members are thought to base their vote on the staff forecast available at the time of the decision. By means of a Hausman test for correlated random effects, it is checked whether model parameters with fixed and random effects are statistically different. A rejection of the random effects model is a necessary condition 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. By means of Wald-tests it can be checked whether parameters in aggregate regression and the corresponding pooled regression are statistically equal.

A comparison of the parameters of (1) with panel regressions (2) or (3) can provide information on

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\[6 \text{ The Taylor principle recommends that monetary policy moves a (nominal) key interest rate by more than one-for-one with inflation. The reaction functions in this paper satisfy the Taylor principle.} \]
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 ($\alpha$). Second, policymakers may disagree on the response to the inflation forecast or inflation gap (see Berk and Bierut 2005). This form of heterogeneity would imply different slope coefficients ($\beta$). Third, policymakers may have different views on how to respond to the output gap (see Gerlach-Kristen 2006). This form of heterogeneity would imply different slope coefficients ($\gamma$).

Heterogeneity in a monetary policy committee may be also attributable to a combination of these factors. For instance, policymakers may assign different weights to inflation control and output smoothing, given different interpretations of the central bank’s mandate. If policymakers 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 policymakers are in a “hawk” or “dove” regime (see Owyang and Ramey 2004). Then, the ratio $\sigma$ could give a supplementary indication on policymakers’ 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 slope parameter estimates. First, committee members may distance themselves from the staff forecast for inflation and output (see Kohn 2008). 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 exchange rates, different modes of leadership in a monetary policy committee (Blinder and Morgan 2007) and disagreements among policymakers on the “true” objective function of monetary policy.

Should final or real-time data be used for the present analysis? Sizeable and extended revisions of economic data are an important source of data uncertainty. There can be substantial lags between the

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7 The ranges in the regularly published forecasts by the policymakers of the FOMC and the Bank of Japan illustrate this point. Unfortunately, the published forecasts are not attributed to individual members, but only provide a central tendency and the complete range.
first release and the last release of a data set. In fact, for some economies it may take several years until the process of revising data is finished (e.g. the US). Bernanke (2010) explains that a comparison of the actual federal funds rate and the Taylor rule gives a different message when using a Taylor rule with real-time forecasts of inflation instead of final values. Orphanides (2003) shows that Taylor rule parameter estimates using real-time data can be sensitive to the vintage of data and the concept of the gap variables. Taylor (2010) emphasises that final data should be used whenever the research interest is to assess the setting of the monetary policy stance with the benefit of hindsight.8 Orphanides (2001) and Svensson (2010) prefer to use real-time data when assessing the performance of monetary policy committees given their constraints (data and model uncertainty).

In dynamic panels the model estimates could suffer from autocorrelation. Orphanides (2001) makes the point that it is appropriate to use OLS estimates when real-time data are used.9 Applying a GMM technique (see Arellano and Bond 1991) could have the advantage to provide unbiased estimates of the slope coefficients in a dynamic panel, but it is not necessary here given that the sample does not suffer from a small sample bias in the time dimension.10 In the following, results of pooled regressions are obtained from OLS and from Generalised Least Squares (GLS) random effects coefficient estimates (applying the Swamy-Arora estimator, for details see Baltagi 2001).

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8 Judd and Rudebusch (1998) obtain stable results for an aggregate Taylor rule applying several alternative specifications to the early Greenspan years 1987 to 1997. This can be taken as evidence that the Taylor rule provides a reasonable description of US monetary policy under chairman Greenspan. When using final data for inflation and output gaps, the conventional specification of the Taylor-type reaction function may nevertheless become instable, and it could be preferable to specify a Wicksell-type rule (see Orphanides 2007).

9 Orphanides (2003) applies both OLS and IV estimates (with four lags of the interest rate and of both gap variables) to address a possible simultaneity bias, and concludes that the results for the US are similar.

10 Note in dynamic pooled regressions, the use of a lagged endogenous may imply the possibility that regressors are biased, if standard OLS panel regression techniques are applied. Besley et al. (2008) provide results for the MPC with the Arellano-Bond estimator. Moreover, when applying the Arellano-Bond method (not reported here for brevity of the exposition), results turn out to be broadly similar, but the intercept converges to zero.
4.2 The real-time database

The database comprises data on published voting records and real-time data on interest rates, inflation gap and output gap. Appendix 1 reports in detail about the sources of the data used for this analysis.

The FOMC

The inflation gap is the difference between the inflation forecast 2-years ahead and a (notional) numerical target of 2% (as advocated by Taylor 1993). The assumed numerical value is consistent with longer-run forecasts of inflation by FOMC members conditional on appropriate monetary policy, and with past outturns (for the sample 1993 – 2008, inflation, as measured by the PCE (core) deflator, was on average 1.97 per cent). It is not to suggest that FOMC members would individually or collectively share this value for policy purposes. To date the Fed has not provided an operational definition of price stability, but a value below, but close to 2% is in line with recent clarifications by Chairman Bernanke.

The present paper uses two alternative sources for the inflation forecast in real-time. One is the FOMC’s Greenbook forecasts, which are available to FOMC policymakers in real-time. Romer and Romer (2000) find that Greenbook forecasts are superior to other sources. Greenbook data are currently only available until December 2003. A second is the Survey of Professional Forecasters (SPF) which is publicly available in real-time. How do both measures of the inflation gap track final data? A plot (see Figure 2) shows that for 1993 to 2001 both real-time measures of the inflation gap tend to overestimate its outturn, and for 2001-3 the Greenbook measure underestimates it. Prior to the deflation scare, the Fed’s internal Greenbook real-time measure is closer to the outturn than the SPF measure. After the deflation scare and until the outbreak of the financial crisis, the inflation gap based on the SPF real-time measure (which is based on headline CPI inflation) is reasonably close to the outturn. While some of the deviation is attributable to different definitions, anecdotal evidence suggests that the FOMC indeed overestimated the risk of deflation during the deflation scare of 2002-3 (see US Federal Reserve, Bluebook, June 2003).

*** insert FIGURE 2 about here ***

Concerning the output gap for the US, the paper uses the real-time measure from the Greenbook and a real-time measure recursively estimated from Philadelphia Fed real-time data on capacity utilisation.
The Congressional Budget Office (CBO) reports an alternative measure, which depends on the estimate of the natural rate of unemployment. It therefore may have exaggerated cycles over past years, in particular during the financial crisis (see Weidner and Williams 2009). Alternatively, the (final) output gap series from the OECD can be used. It is rather smooth around turning points. Figure 2 shows that the Greenbook estimates track outturns quite well, whereas the recursive measure reacts more strongly around turning points (i.e. similar to the measure from the CBO).

**The MPC**

Inflation forecasts are conditioned on an interest rate held constant at the latest value. This forecast is part of the information set that MPC policymakers observe in real-time. While the conditioning path for interest rates is unlikely to generate the best forecast, particularly at long horizons, it is the only forecast for which longer time series are available. The use of this path also facilitates a comparison with Besley et al. (2008). When computing the inflation gap, account is taken of a change in the Bank of England’s inflation target. The inflation target was initially 2.5% for the RPIX, and then changed to 2.0% in terms of the CPI (see King 2004). In its inflation projections the Bank uses the CPI as of February 2004, and before that date it provided forecasts based on the RPIX.

Figure 2 shows output and inflation gaps for the UK. A set of recursive estimates for the real-time output gap is computed based on real-time GDP forecasts conditioned on constant interest rates, and a forward-looking measure based on market expectations (with GDP forecasts 2 years ahead). For comparison, (final) output gap data from the OECD’s production function approach is used. The measure is similar to the Treasury’s trend point measure (see HM Treasury 2010). As in other economies, there have been sizeable revisions in the output gap for the United Kingdom. Figure 2 suggests that the MPC may have systematically underestimated the output gap and overestimated the inflation gap in real time. In this respect, the Bank of England’s inflation forecasts seem to closely track the inflation target at the 2 year policy horizon. Moreover, in 2006-7 the MPC was apparently taken by

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11 Note the Bank of England’s MPC also uses forecasts conditional on market expectations, because a constant interest rate path may be less informative when policymakers consider changing the monetary policy stance. At MPC meetings policymakers always evaluate information available from both inflation forecasts.
surprise when an oil and commodity price shock hit the economy and caused the inflation gap to widen.

The Riksbank’s Executive Board

The (real-time) inflation gap for the CPI is the difference between the (2-year ahead) inflation forecast and the inflation target of 2% (and similarly for outturns). Real-time CPI inflation forecasts are conditioned on the assumption used in the main scenario of the Inflation Report. Initially, the Riksbank conditioned staff inflation forecasts on constant interest rates, then changed to a path implied by market expectations. For past years it has used the Riksbank’s own forecast of the future interest rate. These changes to the conditioning path for interest rates aimed to generate the best possible forecast, given information available at the time of the decision. A comparison of inflation forecasts from various sources (see Svensson 2010) shows that the Riksbank’s forecast performance for inflation is generally good, but not better than other comparator institutions (e.g. National Institute of Economic Research).

The Riksbank uses a number of indicators to measure resource utilisation in the economy (see Svensson 2010). One of these measures is the output gap, calculated as the percentage difference between GDP and an estimated trend. For the output gap, the Riksbank publishes a measure computed on the basis of an HP filter which is considered at Board meetings. This series is available for the full sample. The output gap according to the HP method is, however, not a summary indicator on policymakers’ views on resource utilisation. Policymakers always monitor a set of alternative measures constructed with different tools, thereby accounting for uncertainty about the output gap.

Figure 2 shows output and inflation gaps for Sweden. The real-time measure from the Riksbank and the outturn show a close co-movement with some deviations over past years. Like the Bank of England’s MPC, in real-time the Riksbank’s Executive Board somewhat underestimated the output gap (see Svensson 2010). Like most other committees, during the financial crisis the Board underestimated the output loss. These observations are robust to the inclusion of an alternative measure for the outturn from the OECD. Concerning the inflation gap, the real-time measure hovers around zero for most of the sample, and then picks up at the end of it. Like the Bank of England, the Riksbank forecasts inflation to be close to its inflation target of 2% for the CPI at the 2 year ahead policy horizon. Forecast errors are significant around the turn of economic cycles and during recessions (see Svensson 2010).
4.3 Reaction functions for the FOMC, the MPC and the Riksbank’s Executive Board

In general, the present analysis focuses on the sample 1998 to 2008. In order to check for robustness across time and data sets, the paper reports estimates covering alternative samples. For the FOMC the sample 1993 to 2003 real-time data are available from the Greenbook, whereas for the sample 1998 to 2008 real-time data are taken from the SPF and the Philadelphia Fed. For the MPC the subsample 1998 to 2007 and for the Riksbank the subsample 1999 to 2007 is added. The Bank of England’s MPC and the Riksbank’s Executive Board make their projections only once each quarter. When estimating the reaction functions it is assumed that new information from the inflation forecast regularly becomes available at the meeting of its publication. In practice, policymakers meet at a higher frequency and therefore have a richer data set at their disposal including a sensitivity analysis of the effects of changed forecast assumptions for inflation and output.

Unconstrained reaction functions

In a first step, the (unconstrained) reaction functions by Besley et al. (2008) are estimated. Table 2 reports the results for the three monetary policy committees. Overall, pooled and aggregate regressions have a high explanatory power and parameters are significant at conventional levels. In these regressions, the policy rate reacts positively to an inflationary shock and to shocks that widen the output gap. Slope coefficients are significant and have the expected sign.

*** insert TABLE 2 about here ***

A number of interesting results emerge from the estimates. First, the high value of $\rho$ suggests that a large part of the level of interest rates at time $t$ is attributable to inertia in interest rate. It is explained by the fact that at a policy meeting changes in interest rates are made by small amounts of usually 25 or 50 basis points (on rare occasions 75 basis points and more). Second, with one exception the Hausman test favors the fixed effects model over the random effects model. Hence, the fixed effect model is the benchmark for comparing parameters with the aggregate function and a necessary condition for the existence of preference heterogeneity is satisfied. Third, for the sample 1998 to 2008, Wald-tests indicate measurable differences in the intercept ($\alpha$) that tracks preference heterogeneity. Given that for
the two inflation targeters differences in inertia are also observed, this finding has to be further scrutinized using constrained reaction functions. Fourth, for the sample 1998 to 2008, Wald-tests indicate measurable differences of slope coefficients between corresponding aggregate and pooled reaction functions. It suggests the presence of diversity in policymakers’ views on the transmission mechanism. For the FOMC, difference of views on the output gap are significant, whereas for the two inflation-targeting committees differences of views on the inflation forecast are detected. Differences in the slope coefficients may also be an indication that some committee members do not share the staff forecast. In this respect, analyses with published FOMC policymakers’ forecasts provide evidence in favour of differences in members’ forecasts on future inflation and output matter (Gavin 2003, Banternghansa and McCracken 2009). Fifth, in relation to the study by Besley et al. (2008) the paper finds that results for the MPC are broadly similar, but using a real-time measure for the contemporaneous output gap improves the estimates.12

Constrained reaction functions

In a second step, the constrained reaction functions for the three committees are estimated. It allows to test for robustness of the results and to improve the quality of the parameter estimates. Table 3 reports the results for the three monetary policy committees. Again, pooled and aggregate regressions have a high explanatory power and parameters are significant at conventional levels. The policy rate reacts positively to an inflationary shock and to shocks that widen the output gap. Slope coefficients are significant, have the expected sign and can be meaningfully interpreted.

*** insert TABLE 3 about here ***

A number of interesting results emerge from the estimates. First, the high value of \( \rho \) confirms that a large part of the level of interest rates at time \( t \) is attributable to inertia in interest rate. Second, with one exception the Hausman test favors the fixed effects model over the random effects model so that a necessary condition for the existence of preference heterogeneity is satisfied. Third, for the sample 1998

---

12 Besley et al. (2008) use a 12-months forecast for the output gap instead. Their parameter estimates for the MPC suffer from the wrong sign of the output gap coefficient. In their estimates the coefficient for the output gap has a negative sign, but is not significantly different from zero.
to 2008, Wald-tests find no statistically significant differences in the intercept (α). This finding implies means the absence of preference heterogeneity. Fourth, for the sample 1998 to 2008, with the exception of the Riksbank, Wald-tests find no statistically significant differences of slope coefficients between corresponding aggregate and pooled reaction functions. It suggests that diversity in policymakers’ views on the transmission mechanism is unlikely to change the median voter’s position on interest rates. In the case of Sweden diversity of views concerning the output gap is detected in conjunction with diversity in inertia. It may therefore be attributable to changes in the composition of the committee.

5. CONCLUSIONS

Diversity across policymakers is an important feature of voting by monetary policy committees (see Figure 3). The paper uses voting records from three monetary policy committees, the FOMC, the MPC and the Riksbank’s Executive Board together with real-time information on economic variables. In line with the literature, the paper finds that differences in policymakers’ views on the transmission mechanism are important elements of group decision-making in monetary policy committees. Applying individual and aggregate reaction functions, the paper tests for heterogeneity among committee members and identifies possible sources for it. Unconstrained reaction functions show that in all three committees some diversity of views on the inflation and economic outlook is present. Constrained reaction functions find that preference heterogeneity in all three committees is random and preference distributions in all three committees are fairly symmetric around the respective mean. Hence, while heterogeneity among policymakers is an important phenomenon, its presence is unlikely to change the median voter’s position on interest rates. The finding is in line with the infrequent occurrence of split votes in the committees considered.
APPENDIX

A.1 Data and Sources


TABLE A1

*Database and sources*

<table>
<thead>
<tr>
<th></th>
<th>United States</th>
<th>United Kingdom</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voting records</strong></td>
<td>extracted from FOMC minutes</td>
<td>spreadsheet from the website of the Bank of England since June 1997</td>
<td>spreadsheet from the website of the Riksbank since January 1999</td>
</tr>
<tr>
<td><strong>Inflation</strong></td>
<td>a) PCE core deflator</td>
<td>CPI headline, available from 1996.</td>
<td>CPI (source: Statistics Sweden, and available from the Riksbank’s website)</td>
</tr>
<tr>
<td></td>
<td>b) CPI (website of the Federal Reserve Bank of Cleveland)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inflation forecast</strong></td>
<td>a) Greenbook data, chain-weighted GDP price index (until end-2003)</td>
<td>CPI headline, based on constant interest rates, until February 2004 the RPIX was used (extracted from the bank’s interest rate path (extracted</td>
<td></td>
</tr>
<tr>
<td>Output gap (outturn)</td>
<td>a) from FRED (source: Fed St. Louis database)</td>
<td>a) based on HM Treasury data (website HM Treasury)</td>
<td>computations by the Riksbank (source Statistics Sweden)</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>b) from the OECD (OECD database)</td>
<td>b) from the OECD (OECD database)</td>
<td></td>
</tr>
<tr>
<td>Output gap (real-time)</td>
<td>a) Greenbook data (until end-2003), recursive estimate, calculated from the Bank of England’s GDP real-time forecasts</td>
<td>HP measure, (extracted from various Monetary Policy / Inflation Reports of the Riksbank)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) recursive estimate from Fed releases on capacity utilisation (source Fed Philadelphia)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policy rate</td>
<td>Fed funds target rate (Fed website)</td>
<td>Bank Rate (Bank of England website)</td>
<td>Repo rate (Swedish Riksbank website)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LITERATURE


Issing, Otmar. (2005) “Communication, Transparency, Accountability: Monetary Policy in the Twenty-


FIGURES AND TABLES

FIGURE 1
Voting and dissenting in Monetary Policy Committees (1998 – 2008)

The Federal Reserve’s FOMC

The Bank of England’s MPC

The Riksbank’s Executive Board
FIGURE 2
Output and inflation gaps for the US, the UK and Sweden

United States

Output gap

Inflation gap

United Kingdom

Output (OECD measure)

Inflation (greenbook)

Outturn (OECD measure)

Greenbook (real-time measure)

Philadelphia Fed (real-time measure)

Outturn (OECD measure)

United Kingdom

Outturn (based on core PCE inflation)

Bank of England (real-time measure)

Bank of England (real-time measure, constant rates)

Outturn (OECD measure)

Bank of England (real-time measure)

Outturn (based on inflation target)

Market based (real-time measure)
FIGURE 3
Preference distributions of three monetary policy committees

NOTES: The above distributions have been adjusted for the mean of the respective committee.
TABLE 1

Key Voting Characteristics by Selected Monetary Policy Committees (1999 – 2008)

<table>
<thead>
<tr>
<th></th>
<th>Federal Reserve System</th>
<th>Bank of Japan</th>
<th>Bank of England</th>
<th>Swedish Riksbank</th>
<th>Memo item: ECB</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Number of voting members</td>
<td>12</td>
<td>9</td>
<td>9</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>(2) Number of meetings on monetary policy&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular committee meetings per year&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8</td>
<td>14-19</td>
<td>12</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>5 years: 1999 – 2003</td>
<td>45</td>
<td>86</td>
<td>96</td>
<td>54</td>
<td>96</td>
</tr>
<tr>
<td>10 years: 1999 – 2008</td>
<td>94</td>
<td>163</td>
<td>157</td>
<td>90</td>
<td>156</td>
</tr>
<tr>
<td>(3) Number of meetings with changes in policy rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years: 1999 – 2003</td>
<td>19</td>
<td>12</td>
<td>15</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>10 years: 1999 – 2008</td>
<td>45</td>
<td>17</td>
<td>27</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>(4) Frequency of policy rate changes in relation to number of meetings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years: 1999 – 2003</td>
<td>0.42</td>
<td>0.14</td>
<td>0.16</td>
<td>0.26</td>
<td>0.16</td>
</tr>
<tr>
<td>10 years: 1999 – 2008</td>
<td>0.48</td>
<td>0.10</td>
<td>0.17</td>
<td>0.37</td>
<td>0.15</td>
</tr>
<tr>
<td>(5) Frequency of dissents in relation to total votes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years: 1999 – 2003</td>
<td>0.01</td>
<td>0.13</td>
<td>0.16</td>
<td>0.09</td>
<td>by consensus</td>
</tr>
<tr>
<td>10 years: 1999 – 2008</td>
<td>0.02</td>
<td>0.10</td>
<td>0.14</td>
<td>0.08</td>
<td>by consensus</td>
</tr>
</tbody>
</table>

NOTES: Most interest rate changes in the sample were by 25 or 50 basis points. a) Including unscheduled meetings such as conference calls. b) The Executive Board of the Riksbank and the Governing Council of the ECB reduced the number of ordinary meetings at which policy rates can be changed.
### TABLE 2  Unconstrained reaction functions

<table>
<thead>
<tr>
<th>Sample</th>
<th>Coefficients</th>
<th>Equation</th>
<th>$\alpha(1-\rho)$</th>
<th>$\beta(1-\rho)$</th>
<th>$\gamma(1-\rho)$</th>
<th>$\rho$</th>
<th>Prob.</th>
<th>$R^2$</th>
<th>Obs.</th>
<th>Pooled obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FOMC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1993 to 2003</strong></td>
<td>Aggregate</td>
<td></td>
<td>0.287 (0.027)</td>
<td>0.175 (0.015)</td>
<td>0.043 (0.005)</td>
<td>0.936 (0.006)</td>
<td>0.99</td>
<td>132</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td></td>
<td>0.279 (0.029)</td>
<td>0.150 (0.016)</td>
<td>0.051 (0.005)</td>
<td>0.938 (0.007)</td>
<td>0.99</td>
<td>132</td>
<td>1371</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Effects</td>
<td></td>
<td>0.278 (0.030)</td>
<td>0.159 (0.016)</td>
<td>0.046 (0.005)</td>
<td>0.940 (0.006)</td>
<td>&lt;0.01</td>
<td>0.99</td>
<td>132</td>
<td>1371</td>
</tr>
<tr>
<td><strong>1998 to 2008</strong></td>
<td>Aggregate</td>
<td></td>
<td>0.129* (0.011)</td>
<td>0.255 (0.023)</td>
<td>0.031* (0.001)</td>
<td>0.945 (0.003)</td>
<td>0.99</td>
<td>132</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td></td>
<td>0.202* (0.022)</td>
<td>0.198 (0.041)</td>
<td>0.038* (0.002)</td>
<td>0.938 (0.006)</td>
<td>0.99</td>
<td>132</td>
<td>1373</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Effects</td>
<td></td>
<td>0.180 (0.025)</td>
<td>0.205 (0.041)</td>
<td>0.036 (0.002)</td>
<td>0.940 (0.005)</td>
<td>&lt;0.01</td>
<td>0.99</td>
<td>132</td>
<td>1373</td>
</tr>
<tr>
<td><strong>MPC</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1998 to 2007</strong></td>
<td>Aggregate</td>
<td></td>
<td>0.164* (0.012)</td>
<td>0.116* (0.011)</td>
<td>0.061* (0.004)</td>
<td>0.971* (0.003)</td>
<td>0.98</td>
<td>120</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td></td>
<td>0.337* (0.031)</td>
<td>0.256* (0.022)</td>
<td>0.122* (0.009)</td>
<td>0.933* (0.006)</td>
<td>0.98</td>
<td>120</td>
<td>1049</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Effects</td>
<td></td>
<td>0.319 (0.029)</td>
<td>0.236 (0.018)</td>
<td>0.121 (0.008)</td>
<td>0.936 (0.005)</td>
<td>&lt;0.01</td>
<td>0.98</td>
<td>120</td>
<td>1049</td>
</tr>
<tr>
<td>Sample</td>
<td>Coefficients</td>
<td>Equation</td>
<td>α(1-ρ)</td>
<td>β(1-ρ)</td>
<td>γ(1-ρ)</td>
<td>ρ</td>
<td>Prob.</td>
<td>R²</td>
<td>Obs.</td>
<td>Pooled obs.</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
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<td>----</td>
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</tr>
<tr>
<td><strong>1999 to 2007</strong></td>
<td><strong>Aggregate</strong></td>
<td>0.074* (0.017)</td>
<td>0.111* (0.021)</td>
<td>0.086 (0.007)</td>
<td>0.970* (0.005)</td>
<td>0.97</td>
<td>107</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fixed Effects</strong></td>
<td>0.183 (0.068)</td>
<td>0.312 (0.082)</td>
<td>0.072 (0.024)</td>
<td>0.931 (0.020)</td>
<td>0.94</td>
<td>107</td>
<td>226</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Random Effects</strong></td>
<td>0.177* (0.064)</td>
<td>0.328* (0.080)</td>
<td>0.078 (0.023)</td>
<td>0.932* (0.019)</td>
<td>0.68</td>
<td>0.94</td>
<td>107</td>
<td>226</td>
<td></td>
</tr>
<tr>
<td><strong>1999 to 2008</strong></td>
<td><strong>Aggregate</strong></td>
<td>0.108* (0.024)</td>
<td>0.190* (0.029)</td>
<td>0.123 (0.010)</td>
<td>0.950* (0.007)</td>
<td>0.94</td>
<td>119</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fixed Effects</strong></td>
<td>0.309* (0.101)</td>
<td>0.355* (0.115)</td>
<td>0.160 (0.036)</td>
<td>0.877* (0.029)</td>
<td>0.84</td>
<td>119</td>
<td>244</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Random Effects</strong></td>
<td>0.323 (0.103)</td>
<td>0.401 (0.117)</td>
<td>0.153 (0.037)</td>
<td>0.868 (0.029)</td>
<td>0.02</td>
<td>0.84</td>
<td>119</td>
<td>244</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:** Standard errors in brackets. Prob.: Hausman specification test selects the random effects model, if the probability exceeds 5% - otherwise the fixed effects model is sufficient. *) Wald tests reject that parameters are equal at 5% level.
### TABLE 3  Constrained reaction functions for the FOMC

<table>
<thead>
<tr>
<th>Sample</th>
<th>Coefficients</th>
<th>α</th>
<th>β</th>
<th>γ</th>
<th>ρ</th>
<th>Prob.</th>
<th>R²</th>
<th>Obs.</th>
<th>Pooled obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 to 2003</td>
<td>Aggregate</td>
<td>4.449</td>
<td>2.706</td>
<td>0.715</td>
<td>0.939</td>
<td>0.99</td>
<td>131</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td>4.551</td>
<td>2.271</td>
<td>0.877</td>
<td>0.943</td>
<td>0.94</td>
<td>130</td>
<td>1394</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Effects</td>
<td>4.553</td>
<td>2.959</td>
<td>0.701</td>
<td>0.943</td>
<td>0.946</td>
<td>94</td>
<td>1262</td>
<td></td>
</tr>
<tr>
<td>1998 to 2008</td>
<td>Aggregate</td>
<td>2.374</td>
<td>4.599</td>
<td>0.569</td>
<td>0.946</td>
<td>0.99</td>
<td>132</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td>3.055</td>
<td>2.984</td>
<td>0.592</td>
<td>0.933</td>
<td>0.97</td>
<td>132</td>
<td>1381</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Effects</td>
<td>2.632</td>
<td>4.115</td>
<td>0.562</td>
<td>0.942</td>
<td>&lt;0.01</td>
<td>0.97</td>
<td>132</td>
<td>1323</td>
</tr>
<tr>
<td>MPC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997 to 2007</td>
<td>Aggregate</td>
<td>5.150</td>
<td>4.944</td>
<td>2.364</td>
<td>0.950</td>
<td>0.98</td>
<td>126</td>
<td>-</td>
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</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td>5.485</td>
<td>4.183</td>
<td>1.947</td>
<td>0.936</td>
<td>0.96</td>
<td>125</td>
<td>992</td>
<td></td>
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<tr>
<td></td>
<td>Random Effects</td>
<td>5.006</td>
<td>4.058</td>
<td>2.080</td>
<td>0.942</td>
<td>0.046</td>
<td>0.97</td>
<td>125</td>
<td>1046</td>
</tr>
<tr>
<td>Sample</td>
<td>Coefficients Equation</td>
<td>α</td>
<td>β</td>
<td>γ</td>
<td>ρ</td>
<td>Prob.</td>
<td>$R^2$</td>
<td>Obs.</td>
<td>Pooled obs.</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------</td>
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<td>-----------</td>
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<td>-----</td>
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</tr>
<tr>
<td>1997 to 2008</td>
<td>Aggregate</td>
<td>5.285</td>
<td>6.196</td>
<td>2.666</td>
<td>0.948</td>
<td>0.98</td>
<td>138</td>
<td>-</td>
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</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td>5.487</td>
<td>5.663</td>
<td>2.068</td>
<td>0.935</td>
<td>0.96</td>
<td>137</td>
<td>1187</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Effects</td>
<td>5.181</td>
<td>5.438</td>
<td>2.388</td>
<td>0.942</td>
<td>&lt;0.01</td>
<td>0.96</td>
<td>137</td>
<td>1187</td>
</tr>
<tr>
<td>Riksbank’s Executive Board</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999 to 2009</td>
<td>Aggregate</td>
<td>2.057</td>
<td>3.706</td>
<td>2.472*</td>
<td>0.949*</td>
<td>0.96</td>
<td>132</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td>1.924</td>
<td>2.576</td>
<td>1.340*</td>
<td>0.875*</td>
<td>0.90</td>
<td>132</td>
<td>381</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Effects</td>
<td>2.613</td>
<td>1.937</td>
<td>1.370</td>
<td>0.865</td>
<td>&lt;0.01</td>
<td>0.88</td>
<td>132</td>
<td>249</td>
</tr>
</tbody>
</table>

**NOTES:** Standard errors in brackets. Prob.: Hausman specification test selects the random effects model, if the probability exceeds 5% - otherwise the fixed effects model is sufficient. *) Wald tests reject that parameters are equal at 5% level.