Dissent in Monetary Policy Decisions

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Abstract

Voting records indicate that dissents in monetary policy committees are frequent and predictability regressions show that they help forecast future policy decisions. In order to study whether the latter relation is causal, we construct a model of committee decision making and dissent where members' decisions are not a function of past dissents. The model is estimated using voting data from the Bank of England and the Riksbank. Stochastic simulations show that the decision-making frictions in our model help account for the predictive power of current dissents. The effect of institutional characteristics and structural parameters on dissent rates is examined using simulations as well.

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1 Introduction

This paper studies dissenting behavior in monetary policy committees and its implications for policy decisions. The subject matter is potentially important because dissents are a key feature of the minutes and voting records of monetary committees. The data from the committees at the Bank of England, the Riksbank, and the Federal Reserve show that dissents occur frequently: At least one member dissents in 63, 38, and 34 percent of meetings, respectively. However, it is by no means obvious that dissents should matter for policy decisions. By definition, a dissenting vote does not prevent the implementation of the policy preferred by the majority of members. On the other hand, in a setup where members interact repeatedly, a dissenter may have an effect on the future actions of fellow members and, hence, on policy.

In this paper, we report empirical evidence that a current dissent by a committee member is helpful in forecasting the future votes of other members. Thus, for instance, a current dissent in favor of an interest rate cut is a predictor of votes for an interest rate cut by other members in the next meeting. Then, it is not surprising to find that dissents are helpful in forecasting the policy decision of the committee as a whole, as was first pointed out by Gerlach-Kristen (2004) for the Bank of England, and is documented here for the Riksbank and Federal Reserve.[1] We also examine how the predictive power of dissents depends on the seniority and previous dissent rate of the dissenter. More specifically, we construct measures of dissent where dissenting votes are weighted according to either the tenure or the previous voting record of the dissenter. Results show that seniority does not seem to provide additional information and modify the predictive power of equally-weighted dissenting votes. In contrast, dissents by members that have often dissented in the past (i.e., "serial" dissenters) appear to be much less informative about future policy, perhaps because other members may tend to discount them.

Of course, the finding that dissents are useful in forecasting future individual and committee policy actions does not establish a causal relation. Yet, establishing whether the relation is causal or not has important policy implications. If the relationship is not causal, future policy actions are unaffected by the decision to either cast or conceal a dissenting opinion. In this case, it could be argued that internal norms of consensus that discourage

[1] In contrast, Meade (2002) uses FOMC dissents, both official ones in the minutes and verbal ones inferred from the transcripts, for the period 1992 to 1996 and finds that dissents do not help predict future policy changes. Andersson et al. (2006) analyze the effect of dissents on the yield curve in Sweden and find that the minority view, as reflected in the minutes published a few weeks after the monetary policy meetings, has a quantitatively large but statistically insignificant effect on investors' expectations about future Repo rate decisions.

dissent are suboptimal because valuable information that would improve the predictability of future policy changes is not conveyed to the public.[2] A causal relation may arise, for example, in dynamic models where members care about their reputation.[3] In this case, the occurrence of dissent may alter the strategic interactions in the next meeting. As a result, normative conclusions would be less straightforward because transparency may distort the incentives to make correct decisions in the future.

In order to examine the potential role of reputation or other mechanisms in explaining the reported predictability, we pursue the following approach. First, we formulate a model of committee decision making under consensus (or supermajority) rule where current decisions are independent of dissents in the previous meeting. That is, by construction, there is no causal channel through which dissents affect future policy decisions. The model is estimated using individual and aggregate voting data from the Bank of England and the Riksbank. Then, stochastic simulations are used to study how dissenting rates depend on institutional characteristics and structural parameters, and, importantly, whether current dissents help forecast future policy decisions. Under the null hypothesis, the coefficient of our dissent measure would be statistically different from zero a proportion of times equal to the nominal size of the test. However, we find that the test over-rejects and so, a non-causal mechanism may be partly responsible for the predictability results. We provide an intuition for this mechanism, argue that it arises from frictions inherent to collective decision making, and show via simulations that shock persistence magnifies its effect.

The model of committee decision making extends the consensus model in Riboni and Ruge-Murcia (2010) in three directions.[4] First, we relax the assumption that the composition of the committee is fixed over time. This is important for realism and because changes in composition imply changes in the identity of the key members under the consensus protocol. In turn, this means that the inaction interval—that is, the set of status quo policies where policy changes are not possible—varies over time. Furthermore, the cross-sectional variation in policy preferences arising from changes in composition is crucial to identify parameters (e.g., the supermajority requirement) that are not identified if one assumes that the members

[2]This argument is made, for example, by Gerlach-Kristen and Meade (2010). For a discussion of the literature on central bank communication, see Blinder et al. (2008).

[3]To our knowledge this question has not yet been studied by the literature. Visser and Swank (2007), Levy (2007), and Meade and Stasavage (2008) study reputational concerns in committees but they focus on static settings. Conversely, Prendergast and Stole (1996) and Li (2007) analyze sequential decision making but consider a single agent. Depending on the specifics of the model, the above mentioned literature shows that reputational concerns may lead to either anti-herding (i.e., dissent and inconsistent decisions over time) or herding behavior (i.e., conformity and few "mind changes").

[4]We use Riboni and Ruge-Murcia (2010) as our point of departure because in that paper we estimated four different voting protocols using data from five central banks, and found that for all of them the consensus model fits actual policy decisions better than the other models.

of the committee are always the same. Second, we assume that committee members can choose only among a discrete set of interest rate changes. This is important because interest rate changes usually take place in multiples of 25 basis points and because it means that, in addition to decision-making frictions, members face size frictions as well. As we will see below, this implies that the key members face a trade-off between two possible interest rate changes. Instead with continuos policy options, their exact preferred policy option is implementable and these members face no trade-off. Finally, the model incorporates a simple rule for registering dissents. This extension allows us to study the possible implications of dissents for monetary policy under a well defined benchmark.

The paper is organized as follows: Section 2 describes the voting records used in the analysis and reports empirical regularities. Section 3 presents the model of committee decision making. Section 4 outlines the estimation strategy and reports results of the quantitative analysis. Finally, Section 5 concludes and outlines our future research agenda.

2 Empirical Regularities

2.1 Voting Records

The analysis is based on the voting records from three central banks, namely the Bank of England, the Swedish Riksbank, and the U.S. Federal Reserve.

For the Bank of England, we use the voting records of the Monetary Policy Committee (MPC) for the 148 meetings between June 1997 and August 2009.[5] The sample period starts with the first meeting of the MPC and covers the governorships of Sir Edward George and Mervin King (ongoing). The MPC consists of nine members of which five are internal, that is, chosen from within the ranks of bank staff, and four are external appointees. Internal members are nominated by the Governor, while external members are appointed by the Chancellor. Meetings are chaired by the Governor and take place monthly. Decisions concern the target value for the Repo Rate and are made by simple-majority rule on a one-person, one-vote basis. Prior to November 1998, the records report the interest rate preferred by assenting members and whether dissenting members favored a tighter or a looser policy. Thereafter, the records report the interest rates preferred by each member, including the dissenters. These records are available at *www.bankofengland.co.uk.*

[5] Since the data were collected in the Fall of 2009, the samples for all central banks end in August/September of that year. We have considered extending the sample beyond this period but, since monetary policy in the aftermath of the financial crisis has been implemented by means other than interest rate adjustments, it is not clear that recent voting records adequately capture the policy stands of committee members.

For the Riksbank, we constructed the voting records of the Executive Board (EB) using the minutes of the 81 meetings between February 1999 and September 2009. The minutes are available at *www.riksbank.com.* Under the Riksbank Act of 1999, the Executive Board consists of the Governor and five Deputy Governors. Meetings of the EB are chaired by the Governor and take place about seven times a year. During the sample period, the Governors have been Urban Backstrom, Lars Heikensten, and Stefan Ingves (ongoing). Decisions concern the target value for the Repo Rate and are taken by majority vote. However, formal reservations against the majority decision are recorded in the minutes and explicitly state the interest rate preferred by the dissenting member.

For the Federal Reserve, we use the formal voting records of the Federal Open Market Committee (FOMC) for the 183 meetings from August 1987 to September 2009. FOMC meetings are chaired by the Chairman of the Board of Governors. During the sample period, the Chairmen have been Alan Greenspan and Ben Bernanke (ongoing). FOMC decisions concern the target value for the Federal Funds Rate and are taken by majority rule among voting members. Voting members include all the seven members of the Board of Governors, the president of the Federal Reserve Bank of New York, and four members of the remaining district banks, chosen according to an annual rotation scheme. The voting records up to December 1996 were taken from Chappell et al. (2005), and those from January 1997 onwards were constructed by ourselves using the minutes of FOMC meetings, which are available at *www.federalreserve.gov.* Unlike the Riksbank and the Bank of England, dissenting members in the FOMC do not state the exact interest rate they would have preferred, and the minutes record only the direction of their dissent (whether tightening or easing) compared with the policy selected by the committee.

2.2 A Look at the Data

The voting records show that dissents in monetary policy decision are frequent: The fraction of meetings where at least one member dissents is 0.63, 0.38 and 0.34 in the Bank of England, the Riksbank and the Federal Reserve, respectively. The fraction of meetings where exactly one member dissents is about 0.25 in all three central banks, and the fraction where exactly two members dissent is close to 0.20 in the Bank of England and to 0.10 in both the Riksbank and the Federal Reserve. Furthermore, the number of dissenting members in the Bank of England has been the largest possible (four) in about 8 percent of the meetings, with the governor himself a dissenter in two meetings (in August 2005 and in June 2007), and there have been three instances in the Riksbank where three members out of six have expressed a reservation concerning the policy selected by the committee and the Governor has been forced to use his formal tie-breaking power.

As it is well know, dissent behavior varies with the nature of committee membership. In the Bank of England and the Federal Reserve committee members belong to either one of two distinct groups—that is, internal or external in the former case, and Bank president or Board member in the latter case. As shown in Table 1, 70 percent of dissents in our FOMC sample are entered by Bank presidents and they tend to be in favor of a tighter policy than that selected by the committee. Belden (1989) reports similar results using data from 1970 to 1987. Thus, the higher frequency and direction of dissent on the part of Bank presidents appears to be a robust feature of the FOMC.[6] Similarly, 68 percent of dissents in the MPC are entered by external members and they are usually for a looser policy than that adopted by the committee. This observation has been previously reported by Gerlach-Kristen (2003). Spencer (2005) finds that the voting difference between internal and external members is statistically significant (see, also, Harris and Spencer, 2008).

The number of dissents also varies with the type of decision made by the committee (that is, whether no change, easing or tightening). In general, most dissents take place when the committee decides to keep the interest rate unchanged. This is the case for 72 percent of dissents in the Bank of England (that is, 129 out of 179 total dissenting votes), 61 percent in the Riksbank (27 out of 44), and 48 percent in the Federal Reserve (45 out of 94).[7] The more detailed records of the former two banks allow us to examine the nature of the dissents in cases where the committee adjusts the interest rate. In the Bank of England there were 50 dissents in this situation: 29 in favor of keeping the interest rate unchanged and 21 in favor of a policy in the same direction as that adopted by the committee but of a usually larger magnitude.[8] In the Riksbank, there were 17 dissents in meetings where the EB agreed to adjust the interest rate: 11 were in favor of keeping the Repo rate unchanged and 6 in favor of a change in the same direction as that chosen by the committee (in two cases of a

[6] Previous literature suggests that additional factors in FOMC dissent are career background, and regional and political affiliation. Havrilesky and Gildea (1992) argue that Democratic (Republican) appointees dissent more frequently in favor of easier (tighter) monetary policy. Moreover, members who started their career in the government are associated with a preference for easier monetary policy, while the voting records of professional economists are predictable on the basis of partisan affiliation. Meade and Sheets (2005) and Chappell et al. (2008) show that Bank presidents are influenced by economic conditions in their regions. Other work on dissent patterns at the FOMC includes Havrilesky and Schweitzer (1990), Gildea (1992), and Chappell et al. (1995).

[7] Since this result may be partly due to the fact that keeping the status quo is the most common policy decision in all three committees, we also computed the average number of dissents for each type of policy decision. In both the MPC and the EB, keeping the interest rate unchanged generally remains the most controversial policy decision. However, in the case of the FOMC, the highest average number of dissenting votes takes place when the committee lowers the interest rate.

[8] For example, in the MPC meeting on 5 April 2001, the committee agreed to cut the interest rate by 25 basis points but two members dissented in favor of a larger cut of 50 points.

smaller magnitude and in four cases of a larger magnitude).

In summary, about 80, 70, and at least 50 percent of the dissents in the Bank England, the Riksbank, and the Federal Reserve, respectively, arise in situations where individual members prefer a larger interest rate change than the one agreed by the committee, either because (*i*) the rate has been kept unchanged but the dissenter would prefer a change, or (*ii*) the rate has been changed but the dissenter would prefer an even larger change. Overall, this finding suggest that dissents arise from committees being more cautious in adjusting interest rates than an individual would be at a given point in time.

2.3 A Measure of Dissent

Consider a committee $\mathcal{N} = \{1, .., N\}$ and let $\mathcal{J} \subseteq \mathcal{N}$ be a subgroup within the committee. Define the indicator function

$$I(\Delta i_{j,t} - \Delta i_t) = \begin{cases} 1 & \text{if member } j \in \mathcal{J} \text{ prefers a tighter policy than the committee,} \\ 0 & \text{otherwise,} \\ -1 & \text{if member } j \in \mathcal{J} \text{ prefers a looser policy than the committee,} \end{cases}$$

where $\Delta i_{j,t}$ is the policy favoured by member j and Δi_t is the policy selected by the committee. Then, define the measure of dissent

$$L_{\mathcal{J},t} = \sum_{j=1}^{J} (1/J) I(\Delta i_{j,t} - \Delta i_t), \tag{1}$$

where J denotes the cardinality of group $\mathcal{J}$. To lighten the notation, we write L_t instead of $L_{\mathcal{N},t}$ when $\mathcal{J} = \mathcal{N}$. In our empirical analysis, we construct dissent measures for the three committees in our sample (that is, the MPC, the EB, and the FOMC) and for various subgroups, such as, Bank Presidents and Board members of the FOMC, and internal and external members of the MPC of the Bank of England. Figures 1 through 3 respectively plot L_t for the MPC, the EB, and the FOMC.

An attractive feature of our dissent measure is that it is based on an indicator function that can be easily constructed for all three central banks. This allows us to sidestep the problem created by the limited information in the FOMC minutes and the early MPC records, which do not report the interest rate preferred by the dissenter but only his/her preferred policy direction (whether tightening or easing) compared with the policy selected by the committee.

In order to inspect whether conclusions may be affected by the use of an indicator instead of the actual interest rates, we also constructed the measure

$$D_{\mathcal{J},t} = \sum_{j=1}^{J} (1/J) \left(\Delta i_{j,t} - \Delta i_t\right).$$

This measure is the skewness variable used by Gerlach-Kristen (2004, 2009) and (except for the different timing) the minority view indicator in Andersson et al. (2006). Notice that, by construction, $\Delta i_{j,t} - \Delta i_t = 0$ for assenting members, just as in (1). It is clear that both D_t and L_t may be computed for the Riksbank and the Bank of England (after November 1998), while only L_t may be computed for the Federal Reserve. However, since the correlation between both measures is 0.99 for the Bank of England and 0.97 for the Riksbank, it is likely that both measures will lead to similar conclusions and, more importantly, that results for the FOMC will not be hindered by the fact that its records are less detailed than those of the other committees. The main reason both measures are so similar is that dissents are almost always 25 basis points away from the selected policy. For the Riksbank, 82 percent of dissents (36 out of 44) are of 25 points.[9] For the MPC sub-sample for which the preferred policy of dissenting members is recorded, the corresponding statistic is 97 percent (that is, 152 out of 156). Thus, there is a sense in which our dissent measure simply uses the indicator function (± 1) instead of the ± 0.25 that characterizes an overwhelming majority of dissents.

Notice that our dissent measure in (1) weights equally all dissents. As part of this project, we also construct a related measure where more senior members receive a larger weight than more junior ones, and one where members who have dissented often in the past have a larger weight than those who have not. The first measure seeks to capture the idea that individuals with more experience may have more influence in committee decisions. Let $S_{j,t}$ denote the tenure of member $j \in \mathcal{J}$, which coincides with the number of meetings attended until time t. Then, the dissent measure is

$$L^s_{\mathcal{J},t} = \sum_{j=1}^{J} \left(S_{j,t} / \sum_{n=1}^{J} S_{n,t} \right) I(\Delta i_{j,t} - \Delta i_t).$$

In the case where $\mathcal{J} = \mathcal{N}$, L^s_t measures the relative seniority of the dissenter compared to that of all members of the committee. In the case where $\mathcal{J}$ is a strict subset of $\mathcal{N}$, $L^s_{\mathcal{J},t}$ measures seniority relative to that of all members in that group. Defining the weights in this way means that they add up to one regardless of $\mathcal{J}$.[10]

The second measure is designed to assess the effect of "serial" dissenters on future policy decisions. The idea is that individuals who are more willing to openly express their dis-

[9] Of the remaining dissents, 7 are of a size larger than 25 points (1 of 30, and 6 of 50, points), and there is one exceptionally small dissent of 10 basis points.

[10] In preliminary work, we considered a slightly different specification where the seniority of each member of group $\mathcal{J}$ is measured relative to that of all committee members. That is,

$$L^s_{\mathcal{J},t} = \sum_{j=1}^{J} \left(S_{j,t} / \sum_{n=1}^{N} S_{n,t} \right) I(\Delta i_{j,t} - \Delta i_t).$$

However, results using this measure are basically the same as those reported here.

agreement with the committee may (or may not) have more influence on its decisions. Let $H_{j,t}$ denote dissent rate of member $j \in \mathcal{J}$, measured as the proportion of meetings with a dissenting vote in the voting history of member j up to meeting t. Then, the dissent measure is

$$L^h_{\mathcal{J},t} = \sum_{j=1}^{J} \left(H_{j,t} / \sum_{n=1}^{J} H_{n,t} \right) I(\Delta i_{j,t} - \Delta i_t).$$

As before, the weights add up to one regardless of $\mathcal{J}$.

2.4 Effect on Other Members' Votes

In this Section, we investigate whether current dissents help predict individual voting decisions in future meetings. (Given the ambiguity associated with how tenure should be defined for the alternate voting members of the FOMC, we limit the analysis in this section to the Bank of England and the Riksbank.) Specifically, we perform the regression[11]

$$\Delta i_{n,t+1} = \alpha + \beta L_{-n,t} + \boldsymbol{\gamma} \mathbf{x}_t + \xi_t, \tag{2}$$

where $\Delta i_{n,t+1}$ is the interest rate change favoured by member n, $L_{-n,t}$ denotes one of the dissent measures defined in the previous section but where member n is excluded, α is an intercept term, β is a scalar coefficient, $\boldsymbol{\gamma}$ is a $1 \times r$ vector of coefficients, $\mathbf{x}_t$ is a $r \times 1$ vector of regressors, and ξ_t is a disturbance. In particular, we specify $\mathbf{x}_t = [\Delta i_t, \Delta i_{t-1}, \Delta \pi_{t+1}, \Delta u_{t+1}]'$.

Including Δi_t and Δi_{t-1} among the regressors is a simple way to capture the fact that interest rate changes are serially correlated and that, consequently, current and past changes may help forecast a future change. We also include in $\mathbf{x}_t$ the change in inflation and unemployment between the previous and the current meeting.[12] Inflation is measured by the twelve-month percentage change in the Consumer Price Index (Sweden), the Consumer Price Index for All Urban Consumers (United States), the Retail Price Index excluding mortgage-interest payments (United Kingdom until December 2003) and the Consumer Price Index (United Kingdom from January 2004 onwards).[13] The unemployment rate is measured by the deviation of the seasonally adjusted rate from a constant term, but result using a quadratic or a Hodrick–Prescott trend yield similar results to the ones reported here.

[11] In preliminary work, we also performed Probit regressions but conclusions are essentially the same as those based on (2). In this paper we focus on the linear regression model because it has been used by most of the previous literature and we would like to be able to compare our results with theirs.

[12] We also considered a slightly different specification of $\mathbf{x}_t$, that is $\mathbf{x}_t = [\Delta i_t, \Delta i_{t-1}, \Delta \pi_t, \Delta u_t]'$, with basically the same results as those reported.

[13] The change in inflation measure for the United Kingdom is motivated by the fact that until 10 December 2003, the inflation target applied to the twelve-month change in the RPIX, while, thereafter, it applies to the change in the CPI.

At the time when the data were collected, twenty-eight (thirteen) individuals have been members of the MPC (EB). However, since the regression above requires a sufficient number of observations to reliably estimate the parameters, we restrict the sample to members with at least fifteen observations.[14] This criterion limits the number of available MPC members to twenty-two and of EB members to nine.

Estimates of β for MPC members are reported in Table 2 and for EB members in Table 3. As can be seen in both tables, dissents have a positive and (usually) statistically significant coefficient meaning that current dissents help predict future individual policy decisions, even after controlling by changes in inflation and unemployment and past changes in the interest rate. The fact that the coefficient is positive means that a future vote is likely to be in the same direction as that of the current dissent. That is, for example, a dissent for an interest rate cut today is a predictor of votes in favor of an interest rate cut in the next meeting.

Specifically, Column 1 of Table 2 shows that past dissents in the committee as a whole have predictive power over the individual votes of 16 MPC members (out of the 22 in our sample). Exceptions include five external members (Blanchflower, Besley, Buiter, Goodhart and Sentance) and one internal member (Vickers). Interestingly, in three cases (Buiter, Goodhart and Sentance) estimates become significant when considering dissents cast by members of the same group those three members belong to. Similarly, Column 1 of Table 3 shows that dissents at the Riksbank have predictive power over future votes of most members. (The only exception is Mr. Backstrom.)

By looking at Columns 7 and 3 in Tables 2 and 3, respectively, we can see that the seniority of dissenters does not appear to have additional forecasting power over future individual votes: Point estimates are of the same order of magnitude as those obtained when all dissents receive the same weight (see Column 1 in both tables). On the other hand, when the dissenting vote of a member is weighted by the proportion of dissenting votes previously cast by that member, estimates of β have the same (positive) sign and remain statistically significant but their size is considerably reduced. This result is true for both the Bank of England and the Riksbank, and suggests that dissents by "serial" dissenters have less forecasting power over future individuals' decisions, perhaps because other members may tend to discount them.

[14] Note, however, that conclusions are generally robust to using instead thresholds of twelve and twenty observations.

2.5 Predictability of Interest Rate Decisions

After studying individual voting decisions, we now investigate the role of dissents as predictors of future policy actions by the committee as a whole. In addition to the Bank of England and the Riksbank, the analysis in this section includes the decisions by the FOMC. Consider again the regression

$$\Delta i_{t+1} = \alpha + \beta L_t + \boldsymbol{\gamma} \mathbf{x}_t + \xi_t, \tag{3}$$

where Δi_{t+1} is the interest rate change passed by the committee, L_t is one of the dissent measures defined in Section 2.3, and all other notation is as previously defined.

Estimates of β are reported in the first column of Table 4. In all three central banks, dissents by all members have a positive and statistically significant coefficient. This result should not be surprising given that we have previously established that dissenting votes have forecasting power over future votes of most committee members.

The predictive power of dissent holds for the Bank of England when we construct separate dissent measures for internal and external members, although the magnitude of β is smaller for each group separately than for all dissents as a whole.[15] Instead, dissenting votes by Board members in the FOMC do not seem to help predict future policy changes, while those of Bank presidents do, and to a far larger extent than dissents as a whole. In line with the results presented in Section 2.4, we find that the seniority of dissenters does not increase forecasting power and that dissents by "serial" dissenters predict less future committee decisions (see Columns 3 and 5 of Table 4). For the Bank of England, this result is robust to separately considering the dissents of external and internal members.

Table 5 examines the robustness of the results to the control variables included in $\mathbf{x}_t$. Recall that in the benchmark regression $\mathbf{x}_t = [\Delta i_t,\ \Delta i_{t-1},\ \Delta \pi_{t+1},\ \Delta u_{t+1}]'$. In Table 5, regressions include an intercept term, a dissent measure computed using all members, and the variables in $\mathbf{x}_t$ are $[\Delta i_t,\ \Delta i_{t-1},\ \Delta \pi_t,\ \Delta u_t]'$ in regression 1, $[\Delta i_t,\ \Delta i_{t-1},\ \Delta \pi_{t+1}]'$ in regression 2, $[\Delta i_t,\ \Delta i_{t-1}]'$ in regression 3, $[\Delta \pi_{t+1},\ \Delta u_t]'$ in regression 4, and $[\Delta i_t,\ \Delta i_{t-1},\ \Delta \pi_{t+1},\ \Delta y_{t+1}]'$ in regression 5 where y_t the logarithm of the seasonally-adjusted Index of Industrial Production. Regression 1 addresses the concern that because inflation and unemployment data are published with a lag, their current values may not be available for forecasting purposes. Regression 2 considers the case where no output measure is used as a control variable. Regression 3 considers the case where neither inflation nor output are used as controls and so, the forecast is based on an autoregression plus a dissent measure. Regression 4 does not

[15] Gerlach-Kristen (2009) constructs separate measures of dissent for internal and external members and finds that only dissents by outsiders help forecast future policy changes.

control for the serial correlation in interest rate changes. Finally, regression 5 examines the robustness to using the percentage change in the Index of Industrial Production, instead of the change in unemployment, as output measure.

Notice that the coefficients of our dissent measure in Table 5 are positive, statistically significant, and of similar magnitude to the corresponding ones in the benchmark regression (see results for all members in Table 4). The only exception is the regression for the Federal Reserve where past interest rate changes are not controlled for (regression 4). In this case, the estimate of β is positive but quantitatively small and statistically insignificant. A reason to control for lagged interest rate changes in the case of the Federal Reserve is that they tend to be more persistent than in the other two central banks: The sum of the first two autoregressive coefficients of Δi_t are 0.70, 0.63, and 0.59 for the Federal Reserve, the Bank of England, and the Riksbank, respectively. Overall, these results show that the predictability of interest rate decisions on the basis of past dissents is generally robust to using different control variables.

Finally, we perform Granger causality tests. As it is well know, a Granger causality test is not a test of economic causality but rather of statistical forecastability (i.e., whether one variable is helpful in forecasting another one). We estimate a vector autoregression (VAR) involving four variables (that is, Δi_t, $\Delta \pi_t$, Δu_t and L_t) and then perform a F-test of the null hypothesis that past values of L_t are not useful for predicting the future value of Δi_t, controlling for past values of the other variables. The number of lags in the VAR was determined using the Akaike Information Criterion (AIC). As shown in Table 6, the hypothesis that dissent, as measured by L_t, does not Granger-cause interest rate changes can be rejected for all central banks and for all except one of the measures of dissents. In line with previous results, the hypothesis that dissent by Board members does not Granger-cause future policy changes by the FOMC cannot be rejected.

3 A Model of Committee Decision Making and Dissent

Consider a monetary policy committee that consist of the set of members $\mathcal{N} = \{1, .., N\}$, where N is an odd integer.[16] The interest rate preferred by member $n \in \mathcal{N}$ is

$$i^*_{n,t} = a_n + b\pi_t + cy_t + \zeta_t, \tag{4}$$

where i_t is the nominal interest rate, π_t is inflation, y_t is an output measure, a_n is a member-specific intercept, b and c are positive coefficients, and ζ_t is a disturbance with mean zero.

[16] The assumption that N is odd allows us to uniquely pin down the identity of the median and eases the exposition, but it is not essential for our analysis.

The economic model that delivers (4) as the outcome of an optimization problem solved by member n is presented in the Appendix.

In order to examine the role of shock persistence on dissent, we consider two time-series processes for ζ_t: first, ζ_t is a normally distributed white noise with zero mean and variance σ_ζ^2; second, ζ_t follows the moving average

$$\zeta_t = (1 + \phi_1 L + \ldots + \phi_z L^z)\,\epsilon_t,$$

where L is the lag operator, the roots of $(1 + \phi_1 x + \ldots + \phi_z x^z)$ lie outside the unit circle, and the innovation ϵ_t is a normally distributed white noise with zero mean and variance σ_ϵ^2.

Order the N committee members so that individual 1 (N) is the one with the lowest (highest) preferred interest rate, and define the median member as the one with index $m = (N+1)/2$. The decision protocol whereby members come to a decision is as follows. Let q_t be the value of the interest rate at the beginning of the meeting at time t. We refer to q_t as the status quo policy. The policy space is assumed to be discrete. Let $\mathcal{I}$ denote the finite set of feasible interest rates that can be put to a vote. Note that because of the discreteness of $\mathcal{I}$, the committee will not be able, in general, to select one of the (unconstrained) preferred interest rates defined in (4). In each meeting, committee members first vote over the current nominal interest rate. At the end of the voting game, committee members decide whether or not to cast a dissenting opinion.

We first describe the timing of the voting game. Assume that at the beginning of the meeting, the committee decides by simple-majority rule the direction (either increase or decrease) of the interest rate change. Without loss of generality, suppose that the committee decides to consider an interest rate increase. In the second stage of the voting game, suppose that a "clock" initially indicates the status quo. The clock keeps gradually increasing the interest rate in discrete-sized steps (say, of 25 basis points) as long as a supermajority of at least $(N+1)/2 + k$ members gives its consent. The assumption that a qualified majority of votes is needed to pass a policy is a simple way of capturing the idea that monetary policy committees make decisions by consensus. When consensus falls below $(N+1)/2+k$ members, the meeting is concluded and the committee implements the policy reflected on the clock at the time it stopped. It is immediate to observe that the size of the supermajority increases in k, where the integer $k \in [0, (N-1)/2]$ is the minimum number of favorable votes beyond simple majority that are necessary for a proposal to pass.

Committee members are assumed to be forward-looking within each meeting. That is, in giving their consent, they foresee the consequences that this may have on the final decision at the meeting.[17] It bears stressing that voting decisions do not depend on (voting and

[17]However, they abstract from the consequences of their voting decision on future meetings via the status

dissent) decisions that have been made in the previous meeting.

After the voting game, members decide whether or not to dissent. Assume that member n registers a dissent if and only if her preferred policy is sufficiently distant from i_t, the approved policy. It is also assumed that the decision to dissent does not depend on what happened in the previous meeting. That is, a dissent by member n is observed if and only if

$$\left| i^*_{n,t} - i_t \right| > f(k), \tag{5}$$

where $i^*_{n,t}$ is given by (**??**) and $f(k)$ is the consensus norm. The consensus norm is increasing in k, meaning that the more consensual the voting rules, the less willing is member n to dissent. Throughout, we assume that $f(k) \geq 0$ for all positive integers k. In what follows, we use the functional form

$$f(k) = \gamma \left(\frac{2k}{N-1} \right)^{1/2}, \tag{6}$$

where $\gamma > 0$ is a constant coefficient.

In period $t+1$, the committee meets again and a new decision is made. It is assumed that the status quo in the next meeting is $q_{t+1} = i_t$.

Before describing the equilibrium of the voting game, we introduce some notation. Fix any $q_t \in \mathcal{I}$ and let $\bar{i}^*_{n,t}$ denote the preferred interest rate by member n among the feasible interest rates that lie (weakly) above q_t. Similarly, let $\underline{i}^*_{n,t}$ denote the preferred interest rate by member n among the feasible interest rates that lie (weakly) below q_t. In Proposition 1 below, we characterize the equilibrium policy decision that is adopted by the committee.

Proposition 1: *Let q_t be the status quo at time t. The policy outcome at time t is given by*

$$i_t = \begin{cases} \underline{i}^*_{m+k,t}, & \text{if } q_t > \underline{i}^*_{m+k,t}, \\ q_t, & \text{if } \bar{i}^*_{m-k,t} \leq q_t \leq \underline{i}^*_{m+k,t}, \\ \bar{i}^*_{m-k,t}, & \text{if } q_t < \bar{i}^*_{m-k,t}. \end{cases} \tag{7}$$

Proof: First note from (A1), (A2) and (A3) that for each committee member the induced preferences over the interest rate are single-peaked, with a peak given by (**??**). Next, we define the undominated set $\mathcal{U}$ of the supermajority relation in set $\mathcal{I}$ as the set of alternatives that are not defeated in a direct vote against any alternative in $\mathcal{I}$. The set $\mathcal{U}$ contains all feasible alternatives in the interval $[\bar{i}^*_{m-k,t}, \underline{i}^*_{m+k,t}]$.

Let $\tau \geq 0$ denote the time of the "clock" and let Γ^* denote the equilibrium of the voting game. It is claimed that if any policy in $\mathcal{U}$ is the default at any time τ, that policy must

quo. See Riboni and Ruge-Murcia (2010, p. 410), where we argue that removing this assumption does not alter the main thrust of our results.

be the final outcome of the meeting. By way of contradiction, suppose that this is not true. Let $i_{\mathcal{U}}$ denote any policy in $\mathcal{U}$ and let $\widehat{i}$ denote the final outcome in case a supermajority of committee members let the "clock" continue when the default is $i_{\mathcal{U}}$. We need to distinguish two cases: $\widehat{i}$ may or may not belong to $\mathcal{U}$. In the former case, this implies that a supermajority prefers $\widehat{i}$ to $i_{\mathcal{U}}$. This contradicts the initial hypothesis that $i_{\mathcal{U}}$ is in $\mathcal{U}$. Suppose instead that $\widehat{i}$ does not belong to $\mathcal{U}$. This contradicts the hypothesis that $i_{\mathcal{U}}$ belongs to the undominated set. We then conclude that if any policy in $\mathcal{U}$ is the default at any time $\tau \geq 0$, that policy must be the final outcome. This explains why $i_t = q_t$ if $\overline{i}^*_{m-k,t} \leq q_t \leq \underline{i}^*_{m+k,t}$.

If instead $q_t < \overline{i}^*_{m-k,t}$, it is easy to see that the committee will choose to consider an interest rate increase in the first stage of the voting game. In doing so, the "clock" will reach and stop at $\overline{i}^*_{m-k,t}$, which is majority-preferred to any $q_t < \overline{i}^*_{m-k,t}$. Following a symmetric argument, it is easy to show that if $q_t > \underline{i}^*_{m+k,t}$, the committee will agree to reduce the interest rate. In this case, the committee will eventually reach and pass $\underline{i}^*_{m+k,t}$. ¶

Proposition 1 establishes that for status quo policies that are sufficiently extreme, compared with the values preferred by most members, the committee adopts a new policy that is closer to the median outcome. More specifically, suppose that the current status quo at time t is a low interest rate and assume that a positive shock hits the economy. From (4) we know that the preferred interest rate of all committee members move upwards. In this case, Proposition 1 states that the committee will increase the nominal interest rate up to $\overline{i}^*_{m-k,t}$, the preferred alternative (among the ones that can be put on the agenda) by member $m-k$. Note that a nominal interest rate above $\overline{i}^*_{m-k,t}$ would be favoured by a majority of members (including m) but would fall short of the implicit majority requirement in place. Symmetrically, when the current status quo is a high nominal interest rate and a negative shock hits the economy, Proposition 1 establishes that the final decision will be $\underline{i}^*_{m+k,t}$, a more hawkish policy than the one favoured by m.

According to Proposition 1, when instead the status quo lies close to the median's preferred policy, the committee does not change the interest rate. In other terms, our voting game features an inaction (or gridlock) interval, that is, a set of status quo policies where policy changes are not possible (i.e., the clock simply does not get started). The inaction interval includes all status quo policies $q_t \in [\overline{i}^*_{m-k,t}, \underline{i}^*_{m+k,t}]$ and its width is increasing in the size of the supermajority, k. Note that when $k = 0$, this model predicts no inaction interval and delivers the median's preferred interest rate (among the feasible ones) regardless of the initial status quo. In other words, k measures the extent of decision-making frictions due to the implicit supermajority requirement.

To summarize, the main parameters that determine dissent in this model are the supermajority requirement k and the coefficient γ, both of which enter the consensus norm, $f(\cdot)$. In addition, preference heterogeneity, as measured by the variance of a_n, plays a role in dissenting behavior because it implies that the members' preferred policies are less or more spread out.[18]

It is immediate to see that an increase of γ and/or less heterogeneity of preferences all lead to lower dissent rates. Instead, the effect of k on dissenting behavior is ambiguous. On the one hand, an increase of k raises the right hand side of (5) and discourages dissent. On the other hand, Proposition 1 implies that an increase of k makes the inaction interval wider. This implies that policies that are further away from the median policy (hence, more extreme) may be approved. Because of this, the left-hand side of (5) may increase and, consequently, dissent is more likely to occur.

4 Estimation

4.1 Econometric Strategy

The parameters to be estimated are the coefficients of the individual reaction functions (a_n, b, and c), the process of ζ_t, the coefficient γ, and the supermajority, k. For the case where ζ_t follows a moving average we estimate a MA(1), but results are robust to using higher-order processes. Since the political aggregator—that is, the equilibrium mapping from q_t to i_t—in our decision protocol has two kinks and it is, therefore, non-differentiable, it is not possible to estimate the model using a gradient-based method to optimize a statistical objective function. Thus, we use instead the simulated annealing algorithm in Corana et al. (1987). This algorithm does not require the computation of numerical derivatives to update the search direction and is generally robust to local optima. However, it is subject to the curse of dimensionality because it randomly surveys all dimensions of the parameter space and so estimating a large number of parameters is computationally demanding. For this reason, we use the following two-step strategy.

In the first step, we estimate the individual reaction functions (4) using a fixed-effect projection where, as implied by the model, the intercept is member-specific and the coefficients of inflation and unemployment are the same for all members. The dependent variable is the preferred interest rate by committee members taken from the MPC and EB voting records. The data on inflation and unemployment were described above in Section 2.1. In the case of the Bank of England, the inflation target enters as a separate regressor because

[18] In the Appendix, see expression (A6), we obtain that an increase in inflation volatility, σ_π, leads to more spread out policy preferences.

its value was adjusted in December 2003 (see footnote 13), while in the case of the Riksbank, it is subsumed in the intercept because its value is constant throughout the sample. This means that the estimates of the intercepts are not comparable across the two central banks. The total number of pooled observation is 1169 and 478 for the Bank of England and the Riksbank, respectively. Pooling the data increases the precision of the estimates and permits the use of data from all members, including those with a small number of observations.

In the second step, with the reaction function coefficients fixed and given a value of the supermajority (k), we estimate γ by the simulated method of moments (SMM). SMM was originally proposed by McFadden (1989) and Pakes and Pollard (1989) for the estimation of discrete-choice models in i.i.d. environments, and later extended by Lee and Ingram (1991) and Duffie and Singleton (1993) for the estimation of time-series models with serially correlated shocks. Under the conditions spelled out in Duffie and Singleton (1993), the SMM estimator is consistent and asymptotically normal. Intuitively, this estimator minimizes the weighted distance between the moments computed from the data and those implied by the model, where the latter are obtained by means of stochastic simulations.

In this application, we use the identity matrix as weighting matrix and compute the long-run variance of the moments using the Newey-West estimator with a Barlett kernel and bandwidth given by the integer of $4(T/100)^{2/9}$ where T is the sample size. Since the analysis takes inflation and unemployment as given, we simulate 100 histories and compute the moments of the model by pooling all simulated data. For realism, the set of feasible interest rates that can be put to a vote is restricted to multiples of 25 basis points. The moments used to estimate the model are the variance and the first-order autocovariance of the interest rate, and the proportion of dissents. Recall that the simulations take as given the supermajority, k. Thus, we construct an estimate of k by performing this second step for all admissible values of k and comparing the values of the SMM objective function at the minimum. Our estimate of k is the value that delivers the lowest value of the objective function among all values of k. Note that since, by construction, dissents do not affect voting strategies or outcomes, γ is identified from the proportion of dissents, while the supermajority is identified from the time-series properties of the interest rate.

Results are reported in Tables 7 and 8 for the Bank of England and the Riksbank, respectively.[19] In all cases, the member-specific intercepts are positive and statistically different from zero. The null hypothesis that intercepts are the same for all members can be rejected for both central banks (p-values are < 0.001 in all cases). The inflation response is positive, as expected, and statistically significant. The unemployment response is negative

[19]Note that in these tables, the standard deviation corresponds to σ_ζ in the case where ζ_t is white noise and to σ_ϵ (i.e., the standard deviation of the innovation) in the case where ζ_t follows a MA(1) process.

and statistically significant as well. Estimates of the supermajority are 1 for the Bank of England and 2 for the Riksbank under both time-series models of ζ_t. Estimates of the coefficient in the consensus norm are 1.57 and 1.55 for the Bank of England under the white noise and MA(1) models, respectively, while for the Riksbank are 0.39 and 0.46, respectively.

In order to examine whether these estimates provide a reasonable characterization of individual dissents, Figure 4 plots the actual number of dissents by each member (horizontal axis) and the number of dissents predicted by the model for that member (vertical axis). The latter is computed as the average over 1000 simulated histories of committee meetings, conditional on the observed path of inflation and unemployment and drawing shock realizations from the distribution of ζ_t. Along the continuos 45 degree line, predicted dissents would perfectly match actual dissents. Although, as one would expect, perfect matches are uncommon, there is a general agreement between the model and the data in that members who dissent frequently in the data are also predicted to dissent frequently in the model.

4.2 Quantitative Analysis

In this section, we study the quantitative implications of the model. First, we examine the relation between various committee characteristics and the rate of dissent, defined as the ratio of the number of dissent over the number of votes. Figure 5 plots the predicted dissent rate for different values of the standard deviation of the shock (Column 1), the coefficient γ in the consensus norm (Column 2), and preference heterogeneity (Column 3). The predicted dissent rate is computed as the average dissent rate over 1000 simulated histories for each parameterization.[20] Preference heterogeneity is proxied by the standard deviation of the intercepts in the individual reaction functions, which are affine transformations of the idiosyncractic preference parameter μ_n (see equation (4)).

As we can see in Figure 5 for both the Bank of England (top row) and the Riksbank (bottom row), the dissent rate is only mildly increasing in the standard deviation of the shock. The reason is simply that dissents in the model are determined by the position of the members' preferred policies relative to that selected by the committee. Since shocks are common to all members, they shift the distribution without altering the distance between preferred interest rates. As one would expected, the dissent rate is decreasing in γ and increasing in preference heterogeneity. A larger value of γ means that, given her preferred interest rate and the policy selected by the committee, a member is less likely to register a formal dissent. Larger preference heterogeneity implies a larger standard deviation in the

[20] These simulations are based on the model with MA(1) disturbances, but results based on the model where ζ_t is white noise are basically the same.

distribution of the members' preferred interest rates and, consequently, makes dissents more likely.

Second, using the 1000 simulated histories of MPC and EB meetings, we compute our dissent measure (1) and run the OLS regression (3) for each history. Table 9 reports the proportion of times that the coefficient of the lagged dissent measure (that is, β) is positive and statistically significant. Note that since voting strategies in the model are independent of dissents in the previous meetings, β should equal zero. However, sample variability means that the hypothesis $\beta = 0$ would be rejected 5 percent of the times when one uses a t-test of nominal size equal to 5 percent. Restricting our attention to Column 1 in Panel A (results under the heading White Noise) for the moment, notice instead that the hypothesis can be rejected 11 and 19 percent of times for the Bank of England and the Riksbank, respectively. Furthermore, the 95 percent confidence interval around the empirical size does not include the nominal size of 5 percent. In other words, since the test tends to over-reject the hypothesis, a researcher using data generated from this model would likely find that dissents have predictive power over future policies, despite the fact that, by construction, there is no channel through which dissents affect policy decisions.[21]

In order to understand why current dissents have predictive power in our model, consider the following example. Suppose that in the current meeting a majority of committee members want to increase the interest rate but that this group falls short of the supermajority necessary to pass the policy change. As a result, the status quo policy is kept in place. Because no change has been made, it is likely to observe one (or more) members who dissent in favor of an interest rate increase. Move on now to the next meeting. Depending on the shock realizations, two cases are possible: The distribution of preferred interest rates by committee members shifts either to the right or to the left. In the former case, committee members now generally prefer a higher interest rate and, thus, other members will join the group of individuals advocating an interest rate increase. Since that group already constituted a majority in the previous meeting, an interest rate increase is now very likely to pass. In the latter case, committee members now generally prefer a lower interest rate. Recall, however, that in the previous meeting a majority of members believed that the final interest rate decision implied too loose a monetary policy. After the leftward shift in the distribution, some committee members may revise their opinion but it is unlikely that a broad enough consensus can be reached to pass an interest rate decrease. A more likely outcome is that the committee will maintain the interest rate that was selected in the previous meeting. This heuristic argument relies on moderate shock realizations and, more importantly, on the

[21] Since the sample has 1000 observations and results are robust to using an even larger sample of 5000 observations, it is safe to rule out the possibility that the over-rejection is just a small-sample problem.

existence of an inaction interval under the consensus model. This interval causes symmetric shocks to have asymmetric effects and induces a statistical correlation between dissents and future policy actions, despite the fact that voting strategies are independent of past dissents.

Panel A of Table 9 shows that this asymmetry is further reinforced when shocks are autocorrelated (see results under the heading Moving Average). The reason is simply that now the former case in our example is more likely than the latter one. Thus, after observing one or more dissents in favor of an interest rate increase, an interest rate increase is more likely to pass in the next meeting than an interest rate decrease.

Results in Panel A are based on simulations under the protocol in Section 3.3, which features both decision-making frictions and size frictions. In order to examine the contribution of size frictions to our results, we estimate a version of the model where the set of feasible interest rates that can be put to a vote is continuos. In other words, the committee is still subject to decision-making frictions but it can implement interest rate changes of any size if the supermajority is met. As before, we simulate 1000 histories of MPC and EB meetings, construct the dissent measure (1), run the OLS regression (3) for each history, and compute the proportion of times that the coefficient of the lagged dissent measure is positive and statistically significant. Results are reported in Panel B of Table 9. Comparing results in Panels A and B shows that conclusions are generally robust to excluding size frictions and so, the predictability of future policy decisions on the basis of past dissents is driven primarily by decision-making frictions. On the other hand, it is clear by comparing the estimates for the Riksbank in Panels A and B that size frictions may be empirically important and help amplify the predictive power of dissent.

4.3 Dissent in an MPC without External Members

A large literature on the Monetary Policy Committee of the Bank of England documents differences in the voting patterns of external and internal members (e.g., Gerlach-Kristen, 2003 and 2009; Spencer, 2005; Riboni and Ruge-Murcia, 2008; Besley et al, 2008; and Harris and Spencer, 2008). As pointed out above, one characteristic of external MPC members is that they tend to dissent more often than internal members. It is interesting, thus, to consider an artificial counterpart of the MPC composed only of internal members and compare dissent behavior and policy with the actual MPC and with the Riksbank.

We use the same simulation strategy as above to compute the dissent rate, the proportion of meetings where there is a dissent, and the proportion of dissents for either easing or tightening monetary policy in the MPC without external members. The parameters are the same as those reported in Table 7, except that we use $N = 5$ and $k = 1$ in the consensus norm defined by (6). We set $N = 5$ because the artificial committee consists of five internal members, and $k = 1$ because a larger supermajority requirement (say, $k = 2$) implies unanimity, while a smaller one ($k = 0$) implies that the policy selected by the committee is always that preferred by the median. Thus, $k = 1$ is the only admissible value under the consensus model.

The statistics reported in Table 10 are averages over the 1000 simulated histories and show that the MPC without external members features a lower dissent rate, a smaller proportion of meetings where there is a dissent, and a more equal proportion of dissents for either decreasing or increasing the interest rate compared with the actual MPC with both member types. Indeed, the MPC without external members closely resembles the Executive Board of the Riksbank, where all members are internal.

4.4 Inaction Regions and Dissent Behavior

Data on monetary policy decisions show that central banks do not adjust key interest rates continuously, but frequently keep them unchanged despite the fact that economic variables may have changed since the last time a decision was made. For example, in the case of the Bank of England and the Riksbank, 70 and 56 percent of MPC and EB meetings end with an agreement to keep the interest rate unchanged.

Several explanations have been proposed to account for this empirical observation. Goodhart (1999) argues that central banks are reluctant to make interest rate changes that might need to be subsequently reversed because such actions may be interpreted by outsiders as evidence of inconsistency and damage the central bank's reputation. Eijffinger et al. (1999) and Guthrie and Wright (2004) consider models where the central bank faces small, but unspecified, costs of policy changes. In such environment, the optimal strategy involves an inaction region and a Ss rule whereby the interest rate is adjusted whenever the discrepancy between the desired and the actual rate is large enough.

Our model focuses on decision-making frictions that discourage interest rate adjustments when there is not a sufficiently large support among committee members for a policy change. As shown in Section 3, when the status quo lies "close" to the median's preferred policy, the committee does not change the interest rate. By close, we mean that the status quo belongs to the interval $[\bar{i}^*_{m-k,t}, \underline{i}^*_{m+k,t}]$ where $\bar{i}^*_{m-k,t}$ and $\underline{i}^*_{m+k,t}$ are the interest rates preferred by the key members with indices $m - k$ and $m + k$. Notice that this interval need not be symmetric around the interest rate preferred by the median, m, and that it is time varying because the composition of the committee and, hence, the identity of the key members, changes over time.

Figure 6 plots estimates of this inaction region (dotted lines) and its width (continuos line) for MPC and EB decisions.[22] The panels in first column (that is, Panels A and C) correspond to the model with both decision-making and size frictions. The panels in the second column (that is, Panels B and D) correspond to a version of the model with decision-making frictions only. Three observations are apparent from this figure. First, the width of the inaction region is time-varying. In our model, this result is simply due to the fact the members with different preferences leave/enter the committee over time. Second, the width of the inaction region is relatively narrow, being on average 33 basis points for the Bank of England and 26 basis points for the Riksbank. Thus, our model does not require implausibly large inaction regions to account for the observed policy inertia. Third, the model that incorporates size frictions delivers many instances where the inaction region is nil. Thus, restricting interest decisions to multiples of 25 basis points may make it easier for the committee to accept an interest rate change by reducing the scope for disagreement among committee members. Instead, notice that the model with decision-making frictions only, where interest rate changes of any size are possible, always features a strictly positive inaction region.

Finally, we explore the relationship between the estimated inaction region and dissents. A wide inaction region is associated with large heterogeneity in policy preferences and, as seen in Section 4.2, this makes dissent more likely. Hence, our model predicts a positive relation between the number of dissents and the width of the inaction region. We compute the correlation predicted by the model via the simulation of 1000 histories and find its average number to be 0.71 for the Bank of England and 0.46 for the Riksbank. Thus, although, in general, dissents depend on the complete distribution of preferred policies by members relative to the outcome selected by the committee, the inaction region appears to be a good proxy of preference heterogeneity and, hence, a good predictor of dissent behavior in monetary policy committees.

5 Conclusions

We propose here a stylized model where monetary policy decisions are made by consensus (or supermajority rule) and where dissent decisions are non strategic and involve a simple comparison between the member's preferred policy and the one that is approved at the meeting. In spite of the fact that in our model current (voting and dissent) decisions do not depend on previous dissents, we find that decision-making frictions help account for

[22] These inaction regions correspond to those in the model with MA(1) disturbances, but results for the white noise case are similar and lead to the same conclusions.

robust empirical evidence showing that dissents in monetary policy committees are useful in forecasting future policy decisions.

Throughout our analysis, we have assumed that committee members are only motivated by policy outcomes. An interesting question would be to ask how the predictive power of dissent that we report here would be affected when committee members also care about their reputation. Reputational concerns will likely make current (voting and dissent) decisions depend on previous decisions and introduce a causal link from current dissents to future policy choices. Formally looking at reputational concerns is a key question that is ripe for future research.

A A Model of Individually-Preferred Interest Rates

The utility function of a generic member n is

$$E_\tau\left(\sum_{t=\tau}^{\infty}\delta^{\tau-t}U_n(\pi_t)\right),$$

where E_τ denotes the expectation conditional on information available at time τ, $\delta \in (0,1)$ is the discount factor, and $U_n(\pi_t)$ is the instantaneous utility function. We assume that

$$U_n(\pi_t) = \frac{-\exp\left(\mu_n(\pi_t - \pi^*)\right) + \mu_n(\pi_t - \pi^*) + 1}{\mu_n^2}, \tag{A1}$$

where π^* is an inflation target and μ_n is a member-specific preference parameter. The functional form (A1) is based on Varian (1974).

As in Svensson (1997), the behavior of the private sector is summarized by a Phillips curve

$$\pi_{t+1} = \pi_t + \alpha_1 y_t + \varepsilon_{t+1}, \tag{A2}$$

and an aggregate demand curve

$$y_{t+1} = \beta_1 y_t - \beta_2(i_t - \pi_t - \iota) + \eta_{t+1}, \tag{A3}$$

where π_t is inflation, y_t is an output measure, i_t is the nominal interest rate, ι is the real interest rate, $\alpha_1, \beta_2 > 0$ and $0 < \beta_1 < 1$ are constant parameters, and η_t and ε_t are disturbances. The disturbances follow the moving average processes

$$\begin{aligned}\varepsilon_t &= (1 + \kappa_1 L + \ldots + \kappa_p L^p)\, u_t,\\ \eta_t &= (1 + \varsigma_1 L + \ldots + \varsigma_r L^r)\, v_t,\end{aligned}$$

where L is the lag operator, the roots of $(1 + \kappa_1 x + \ldots + \kappa_p x^p)$ and $(1 + \varsigma_1 x + \ldots + \varsigma_p x^p)$ lie outside the unit circle, and u_t and v_t are mutually independent innovations. The innovations are normally distributed white noises with zero mean and constant conditional variances σ_u^2 and σ_v^2, respectively. Before proceeding, note from (A2) and (A3) that in the model the interest rate at time t affects inflation only after two periods.

Consider the member-specific interest rate $i_{n,t}^*$ chosen at time t to maximize the expected utility of member n at time $t+2$. That is,

$$i_{n,t}^* = \underset{i_t\,\geq\,0}{\arg\max}\ \delta^2 E_t U_n(\pi_{t+2}),$$

subject to equations (A2) and (A3). Because of the shocks that occur during the control lag period, ex-post inflation will typically differ from π^*. This induces a prudence motive in the conduct of monetary policy which varies with μ_n. The first-order necessary condition is

$$E_t \exp\left(\mu_n(\pi_{t+2} - \pi^*)\right) = 1. \tag{A4}$$

Under the assumption that innovations are normally distributed, the inflation rate at time $t+2$ (conditional on the information available at time t) is also normally distributed. Thus, $\exp\left(\mu_n(\pi_{t+2} - \pi^*)\right)$ is distributed Log-normal with mean $\exp\left(\mu_n(E_t\pi_{t+2} - \pi^*) + \mu_n^2\sigma_\pi^2/2\right)$ where σ_π^2 stands for the conditional variance of π_t. Substituting into (A4) and taking logs,

$$E_t\pi_{t+2} = \pi^* - \mu_n\sigma_\pi^2/2.$$

Finally, using equations (A2) and (A3), it is possible to write the interest rate preferred by member n as

$$i_{n,t}^* = a_n + b\pi_t + cy_t + \zeta_t, \tag{A5}$$

where

$$a_n = \iota - (1/\alpha_1\beta_2)\pi^* + (\mu_n/2\alpha_1\beta_2)\,\sigma_\pi^2, \tag{A6}$$

$b = 1 + (1/\alpha_1\beta_2)$, $c = (1+\beta_1)/\beta_2$, and ζ_t is a reduced-form disturbance. It is easy to show that in the special case where ε_t and η_t both follow MA(1) processes, ζ_t is a white noise; while in the more general case where $p > 1$ or $r > 1$, ζ_t follows a moving average process.

Table 1. Number of Dissents

	Dissents		
		For	For
Central Bank	Total	Easing	Tightening
Bank of England			
All members	179	101	78
		(0.56)	(0.44)
Internal members	57	14	43
		(0.25)	(0.75)
External members	122	87	35
		(0.71)	(0.29)
Riksbank			
All members	44	22	22
		(0.50)	(0.50)
Federal Reserve			
All members	94	27	67
		(0.29)	(0.71)
Bank presidents	66	9	57
		(0.14)	(0.86)
Board members	28	18	10
		(0.64)	(0.36)

Note: The figures in parenthesis are the proportion of dissents in a given direction over the number of total dissents.

Table 2. Predictability of Individual Votes
Bank of England

	Weight in Dissent Measure									
	Equal						Seniority		Dissent Rate	
	All		Internal		External		All		All	
Member	β	s.e.	β	s.e	β	s.e	β	s.e.	β	s.e.
Allsopp‡	0.391*	0.131	0.256	0.130	0.396*	0.111	0.384*	0.121	0.252*	0.079
Barker‡	0.630*	0.119	0.426*	0.117	0.358*	0.083	0.571*	0.134	0.333*	0.069
Bean	0.476*	0.103	0.343*	0.113	0.262*	0.065	0.448*	0.114	0.265*	0.061
Bell‡	0.353*	0.132	0.292	0.173	0.235*	0.085	0.349*	0.137	0.185*	0.070
Besley‡	0.683	0.377	0.436	0.345	0.492	0.278	0.568	0.436	0.386	0.240
Blanchflower‡	0.393	0.362	0.182	0.334	0.322	0.259	0.153	0.421	0.288	0.245
Buiter‡	0.487	0.384	0.108	0.281	0.651*	0.313	0.442	0.400	0.556	0.293
Clementi	0.413*	0.108	0.298*	0.134	0.352*	0.075	0.389*	0.107	0.227*	0.060
George^c	0.236*	0.087	0.155	0.098	0.190*	0.062	0.236*	0.086	0.142*	0.050
Gieve	0.798*	0.299	0.417	0.366	0.448*	0.169	0.636	0.377	0.447*	0.161
Goodhart‡	0.194	0.175	0.010	0.188	0.267*	0.122	0.181	0.173	0.133	0.093
Julius‡	0.331*	0.128	0.253*	0.116	0.359*	0.131	0.326*	0.137	0.170*	0.086
King^c	0.439*	0.095	0.325*	0.110	0.261*	0.060	0.434*	0.110	0.267*	0.055
Lambert‡	0.314*	0.092	0.249*	0.103	0.214*	0.068	0.327*	0.099	0.220*	0.069
Large	0.330*	0.112	0.356*	0.174	0.178*	0.066	0.334*	0.119	0.224*	0.072
Lomax	0.229*	0.083	0.197*	0.088	0.120*	0.055	0.182	0.980	0.150*	0.052
Nickell‡	0.588*	0.102	0.374*	0.099	0.415*	0.083	0.516*	0.106	0.385*	0.070
Plenderleith	0.339*	0.118	0.162	0.135	0.337*	0.083	0.349*	0.121	0.199*	0.069
Sentance‡	0.698	0.366	0.434	0.340	0.581*	0.292	0.596	0.426	0.422	0.217
Tucker	0.510*	0.130	0.568*	0.158	0.226*	0.078	0.451*	0.151	0.282*	0.074
Vickers	0.134	0.184	−0.053	0.205	0.196	0.129	0.116	0.181	0.079	0.098
Wadhwani‡	0.414*	0.145	0.292*	0.133	0.437*	0.138	0.414*	0.134	0.260*	0.091

Note: The sample excludes committee members Budd, Davies, Walton, Dale, Fisher, and Miles because the number of their available observations is less than fifteen. The superscripts ‡ and c respectively denote an external member and a current/former chairman. The superscript $*$ denotes statistical significance at the 5 percent level.

Table 3. Predictability of Individual Votes
Swedish Riksbank

	Weight in Dissent Measure					
	Equal		Seniority		Dissent Rate	
Member	β	s.e.	β	s.e.	β	s.e
Bäckström[c]	0.431	0.222	0.442	0.237	0.164	0.093
Bergström	0.557*	0.193	0.929	0.256	0.285*	0.098
Heikensten[c]	0.521*	0.163	0.609*	0.177	0.287*	0.085
Ingves[c]	0.717*	0.241	0.523*	0.182	0.469*	0.143
Nyberg	0.513*	0.141	0.730*	0.209	0.283*	0.085
Öberg	0.706*	0.291	0.528*	0.192	0.526*	0.235
Persson	0.591*	0.145	0.754*	0.217	0.551*	0.192
Rosenberg	0.654*	0.176	0.640*	0.185	0.423*	0.122
Srejber	0.885*	0.243	0.895*	0.255	0.413*	0.140

Note: The sample excludes committee members Hessius, Wickman-Parak, Svensson, and Ekholm because their number of observations is less than fifteen. The superscript c denotes a current/former chairman. The superscript $*$ denotes statistical significance at the 5 percent level.

Table 4. Predictability of Committee Decisions

	Weight in Dissent Measure					
	Equal		Seniority		Dissent Rate	
Central Bank	β	s.e	β	s.e.	β	s.e
Bank of England						
All members	0.358*	0.075	0.333*	0.079	0.193*	0.042
Internal members	0.285*	0.085	0.261*	0.091	0.139*	0.053
External members	0.223*	0.050	0.194*	0.047	0.159*	0.035
Riksbank						
All members	0.551*	0.151	0.492*	0.132	0.260*	0.078
Federal Reserve						
All members	0.498*	0.230	–	–	–	–
Bank presidents	0.764*	0.278	–	–	–	–
Board members	−0.043	0.390	–	–	–	–

Note: s.e. stands for standard error. The dependent variable is the change in the policy variable, Δi_{t+1}. The regressions also included an intercept, two lags of the change in the policy variable, and the change in inflation and unemployment since the previous meeting. The superscript $*$ denotes statistical significance at the 5 percent level.

Table 5. Robustness

		Weight in Dissent Measure					
		Equal		Seniority		Dissent Rate	
Regression	Central Bank	β	s.e	β	s.e.	β	s.e
1	Bank of England	0.354*	0.075	0.330*	0.079	0.193*	0.042
	Riksbank	0.608*	0.174	0.535*	0.151	0.269*	0.090
	Federal Reserve	0.505*	0.233	–	–	–	–
2	Bank of England	0.361*	0.075	0.336*	0.079	0.195*	0.042
	Riksbank	0.558*	0.152	0.492*	0.132	0.262*	0.262
	Federal Reserve	0.536*	0.231	–	–	–	–
3	Bank of England	0.353*	0.075	0.327*	0.079	0.191*	0.042
	Riksbank	0.640*	0.164	0.561*	0.143	0.289*	0.086
	Federal Reserve	0.544*	0.232	–	–	–	–
4	Bank of England	0.338*	0.087	0.317*	0.092	0.205*	0.048
	Riksbank	0.415*	0.175	0.356*	0.153	0.218*	0.090
	Federal Reserve	0.078	0.258	–	–	–	–
5	Bank of England	0.356*	0.073	0.336*	0.077	0.188*	0.041
	Riksbank	0.572*	0.155	0.489*	0.137	0.263*	0.079
	Federal Reserve	0.555*	0.229	–	–	–	–

Note: s.e. stands for standard error. The dependent variable is the change in the policy variable, Δi_{t+1}. The explanatory variables are a constant, the dissent measure, and the variables in $\mathbf{x}_t$, where $\mathbf{x}_t = [\Delta i_t,\, \Delta i_{t-1},\, \Delta\pi_t,\, \Delta u_t]'$ in regression 1, $\mathbf{x}_t = [\Delta i_t,\, \Delta i_{t-1},\, \Delta\pi_{t+1}]'$ in regression 2, $\mathbf{x}_t = [\Delta i_t,\, \Delta i_{t-1}]'$ in regression 3, $\mathbf{x}_t = [\Delta\pi_{t+1},\, \Delta u_{t+1}]'$ in regression 4, and $\mathbf{x}_t = [\Delta i_t,\, \Delta i_{t-1},\, \Delta\pi_{t+1},\, \Delta y_{t+1}]'$ in regression 5 with y_t the logarithm of the Index of Industrial Production. The superscript $*$ denotes statistical significance at the 5 percent level.

Table 6. Granger Causality Tests

	Weight in Dissent Measure				
	Equal			Seniority	Dissent Rate
Central Bank	All	External or Presidents	Internal or Board	All	All
Bank of England	26.00	22.79	13.16	20.18	24.63
	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)	(< 0.001)
Riksbank	16.54	–	–	16.55	12.40
	(< 0.001)			(< 0.001)	(< 0.001)
Federal Reserve	3.60	7.97	0.03	–	–
	(0.03)	(< 0.001)	(0.97)		

Note: This table report the F-statistic and p-value (in parenthesis) for the null hypothesis that dissents do not help forecast future interest rate changes. The numbers of lags in the vector autoregressions are 1 (Bank of England and Riksbank) and 2 (Federal Reserve), and were chosen using the Akaike Information Criterion (AIC).

Table 7. Parameter Estimates
Bank of England

Parameter	White Noise Estimate	White Noise s.e.	Moving Average Estimate	Moving Average s.e.
Individual intercepts				
Allsopp‡	5.607*	0.389	5.339*	0.320
Barker‡	5.177*	0.327	4.893*	0.253
Bean	5.288*	0.329	5.022*	0.256
Bell‡	4.638*	0.356	4.381*	0.292
Besley‡	5.666*	0.331	5.356*	0.440
Blanchflower‡	5.549*	0.330	5.245*	0.882
Budd‡	7.954*	0.491	7.808*	0.401
Buiter‡	7.515*	0.416	7.276*	0.337
Clementi	6.641*	0.384	6.374*	0.304
Dale	4.813*	0.386	4.558*	0.318
Fisher	4.413*	0.473	3.747*	0.411
George^c	6.287*	0.381	6.023*	0.286
Gieve	5.789*	0.328	5.464*	0.400
Goodhart‡	7.563*	0.416	7.336*	0.336
Julius‡	7.233*	0.395	6.949*	0.321
King^c	5.707*	0.335	5.372*	0.257
Lambert‡	4.728*	0.338	4.483*	0.282
Large	4.737*	0.345	4.490*	0.282
Lomax	5.315*	0.318	5.036*	0.255
Miles‡	4.706*	0.590	4.201*	0.472
Nickell‡	5.203*	0.348	4.975*	0.272
Plenderleith	6.736*	0.386	6.476*	0.306
Sentance‡	5.648*	0.332	5.356*	0.337
Tucker	5.173*	0.322	4.886*	0.252
Vickers	7.558*	0.407	7.302*	0.331
Wadhwani‡	6.410*	0.389	6.064*	0.347
Walton‡	5.177*	0.382	4.852*	0.333
Inflation	0.222*	0.043	0.187*	0.033
Inflation target	−0.726*	0.148	−0.552*	0.119
Unemployment	−1.250*	0.045	−1.165*	0.041
Standard deviation	0.848*	0.026	0.532*	0.010
MA coefficient	–	–	0.780*	0.012
Coefficient in consensus norm	1.571*	0.084	1.553*	0.083
Supermajority	1		1	

Note: The superscripts ‡ and c respectively denote an external member and a current/former chairman. The superscript $*$ denotes statistical significance at the 5 percent level.

Table 8. Parameter Estimates
Swedish Riksbank

	White Noise		Moving Average	
Parameter	Estimate	s.e.	Estimate	s.e.
Individual intercepts				
Bäckström[c]	2.650*	0.091	2.753*	0.114
Bergström	2.474*	0.073	2.464*	0.089
Ekholm	1.416*	0.283	1.156*	0.307
Heikensten[c]	2.461*	0.073	2.447*	0.089
Hessius	2.797*	0.127	2.928*	0.157
Ingves[c]	1.982*	0.112	1.913*	0.135
Nyberg	2.308*	0.066	2.286*	0.079
Öberg	1.985*	0.109	1.912*	0.132
Persson	2.227*	0.083	2.153*	0.010
Rosenberg	2.139*	0.087	2.034*	0.104
Srejber	2.458*	0.070	2.440*	0.085
Svensson	1.807*	0.137	1.831*	0.167
Wickman-Parak	1.907*	0.137	1.931*	0.162
Inflation	0.504*	0.026	0.526*	0.026
Unemployment	−0.410*	0.029	−0.226*	0.029
Standard deviation	0.479*	0.017	0.402*	0.013
MA coefficient	–	–	0.555*	0.035
Coefficient in consensus norm	0.385*	0.007	0.458*	0.006
Supermajority	2		2	

Note: The superscript c denotes a current/former chairman. The superscript $*$ denotes statistical significance at the 5 percent level.

Table 9. Proportion of Histories where Dissents Forecast Decisions

Central Bank	White Noise		Moving Average	
	Estimate	s.e.	Estimate	s.e.
A. Decision-making and size frictions				
Bank of England	0.114	0.010	0.323	0.015
Riksbank	0.194	0.013	0.416	0.016
B. Decision-making frictions only				
Bank of England	0.117	0.010	0.314	0.015
Riksbank	0.194	0.013	0.191	0.012

Note: The percentages were computed using 1000 simulated histories, the parameters reported in Tables 7 and 8, and regressions identical to that in (3). Since, by construction, dissents do not affect future voting strategies, the proportion of histories where dissents forecast decisions should be 0.05.

Table 10. Dissent in an MPC without External Members

Central Bank	Dissent Rate	Meetings with Dissents	Proportion of Dissents For Easing	Proportion of Dissents For Tightening
Bank of England				
Actual	0.133	0.628	0.564	0.436
Without external members	0.030	0.259	0.485	0.515
Riksbank				
Actual	0.095	0.383	0.500	0.500

Note: The statistics for the MPC without external members were computed on the basis of 1000 simulated histories. The statistics for the current MPC and for the EB were computed by the authors.

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Figure 1: Dissent Measure
Bank of England (MPC)

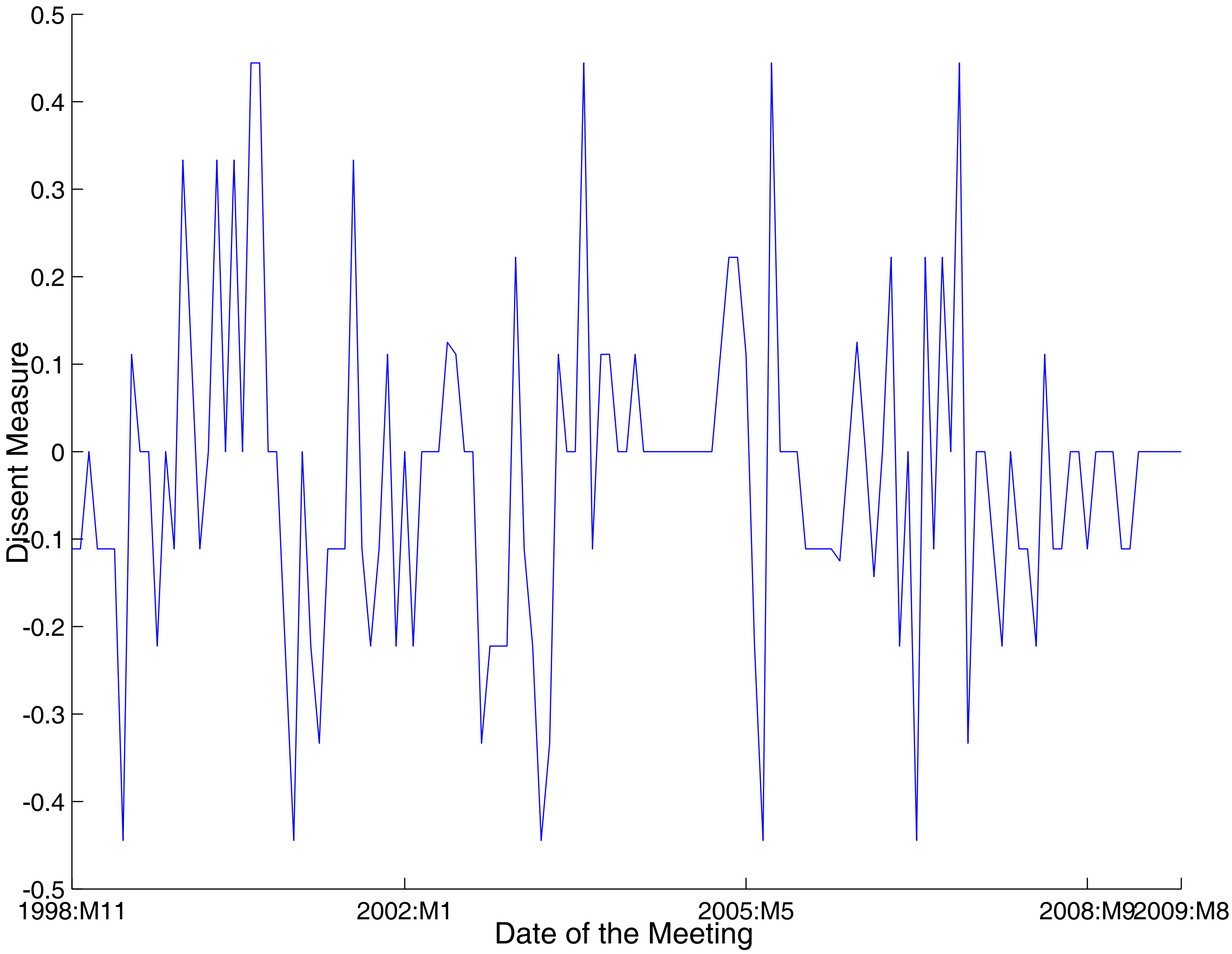

Figure 2: Dissent Measure
Riksbank (EB)

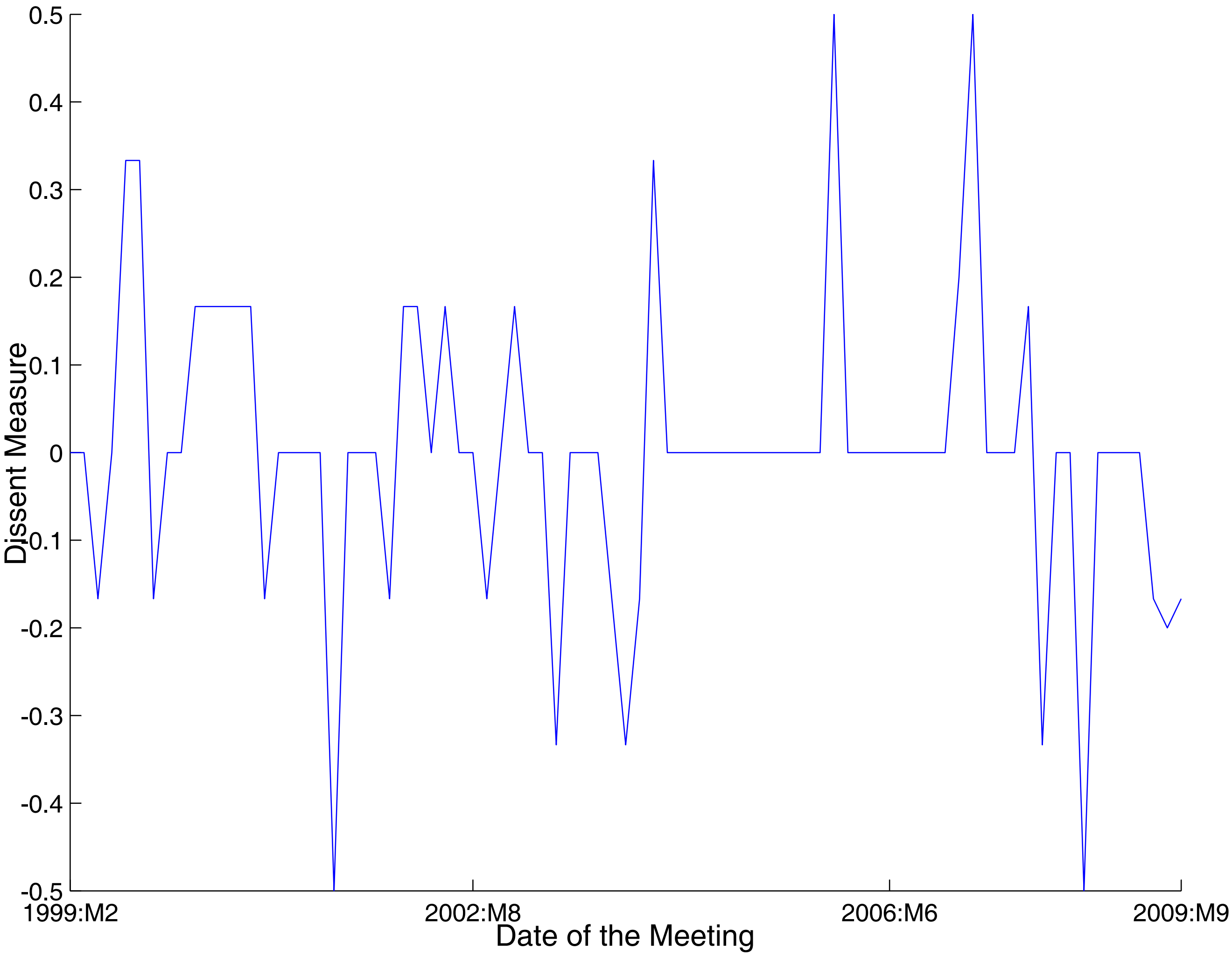

Figure 3: Dissent Measure
Federal Reserve (FOMC)

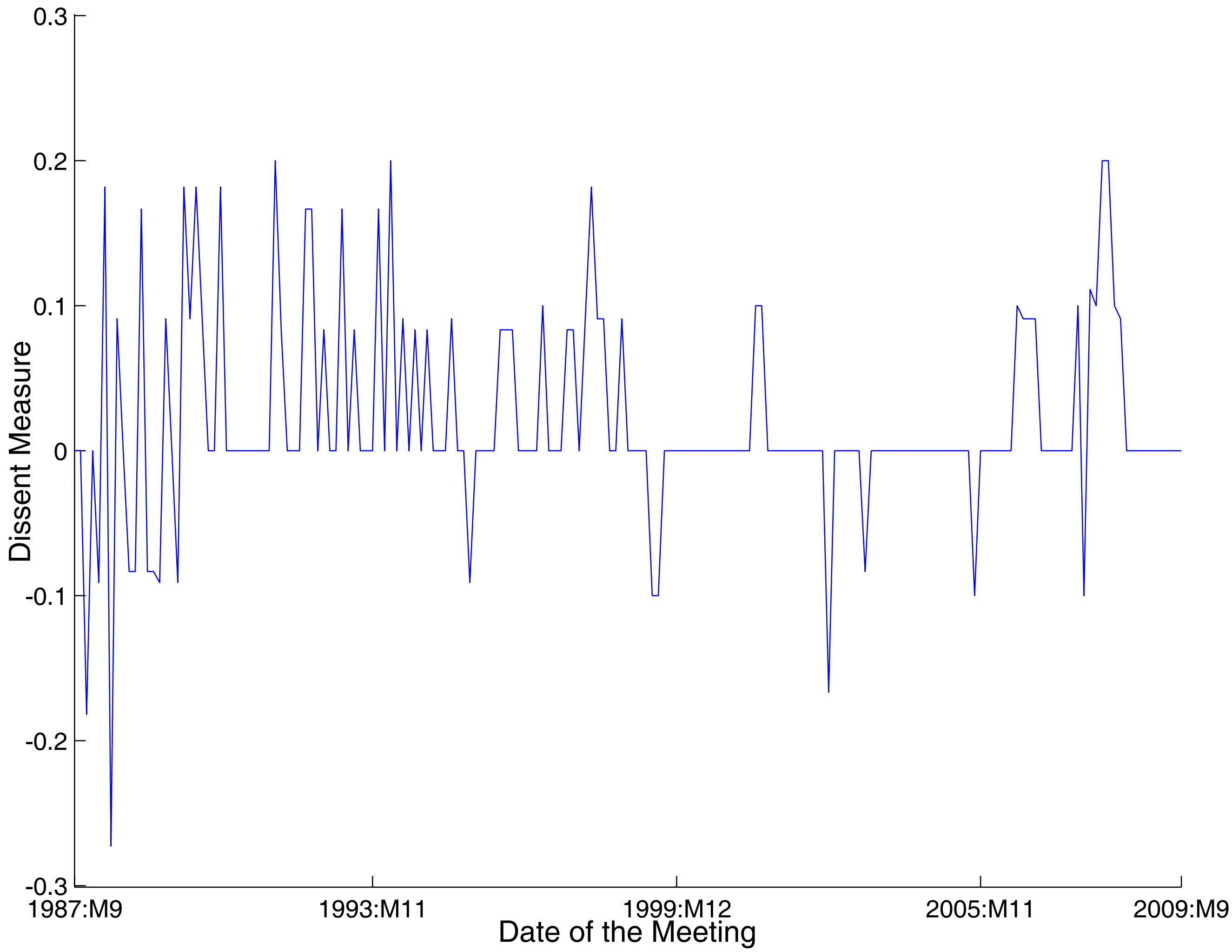

Figure 4: Actual versus Predicted Dissents

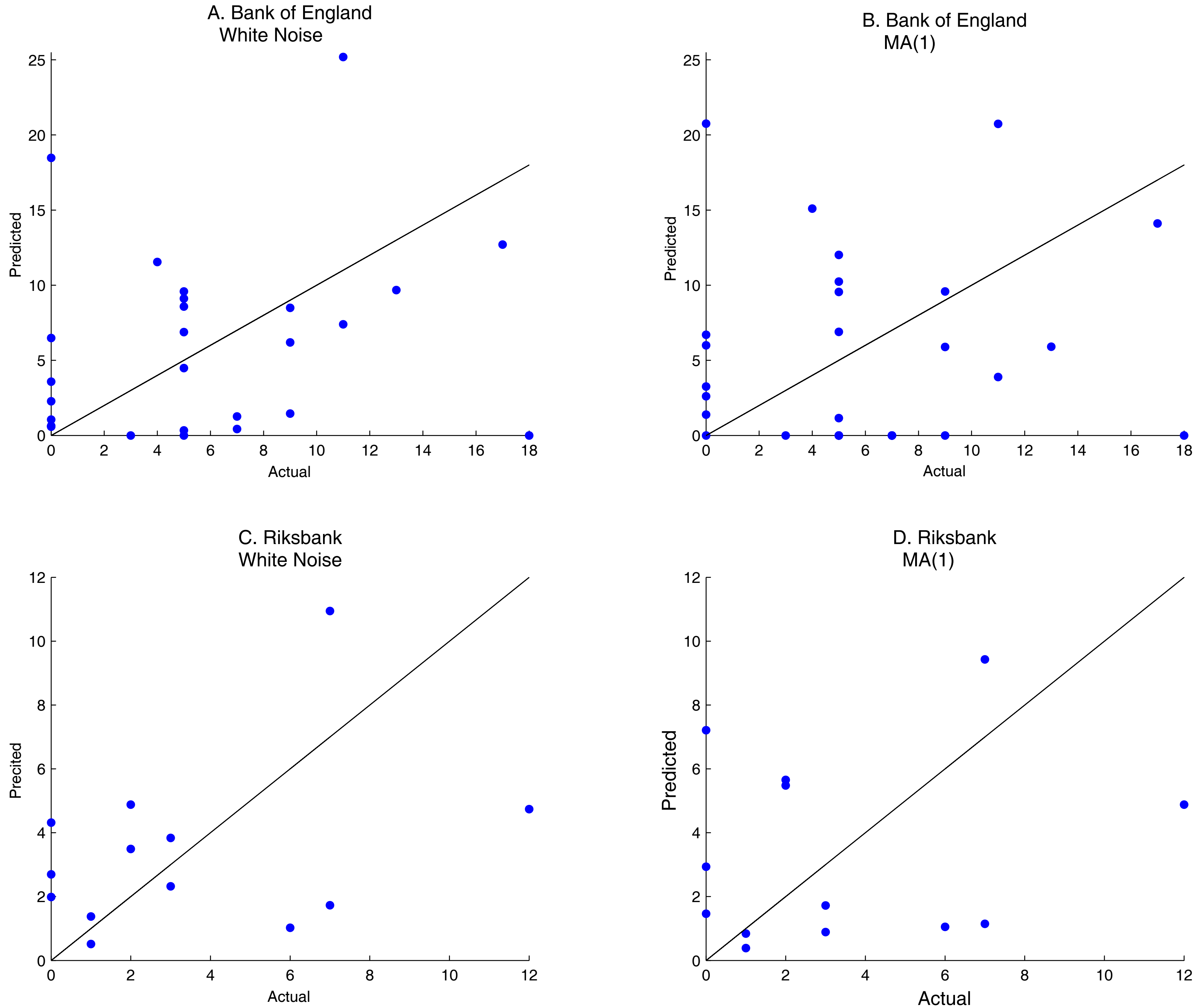

Figure 5: Relation between Dissent Rate and Committee Characteristics

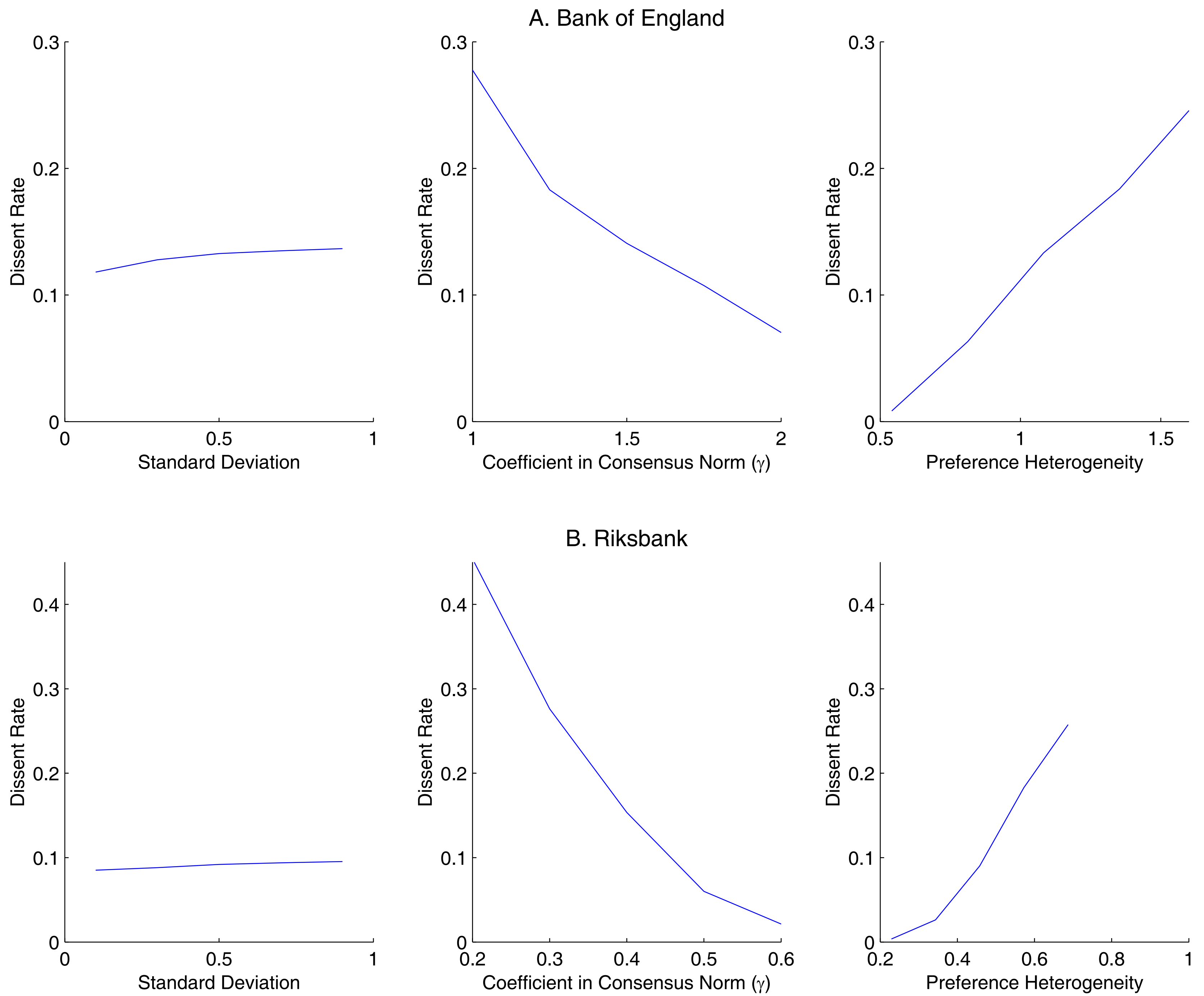

Figure 6: Estimated Inaction Regions