

Two-tiered MPCs and the implications for monetary policy

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March 13, 2007

Abstract

We study the voting behavior of members of MPCs similar in structure to those in the US and the euro area. We find that arrangements that foresee in members of the center preparing policy proposals for discussion in the MPC maximise the quality of monetary policy only when one assumes that these members are in a better position to identify the correct state of the economy in the currency area from the evidence available to all MPC members. If not, suboptimal monetary policy will result.

JEL Classification: D71, D78, E58

Keywords: monetary policy, collective choice, juries, strategic voting

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[‡]The authors thank Robert Paul Berben, Bryan Chapple, Petra Gerlach-Kristen, Otto Swank, Job Swank, Bauke Visser, and seminar participants at De Nederlandsche Bank, the Polish National Bank, Western Economic Association, Southern Economic Association and Hong Kong Economic Association for their invaluable help and suggestions. The views expressed are those of the authors only.

1 Introduction

Monetary policy decisions nowadays are mostly made by committees, yet most textbooks on monetary policy are based on the assumption that policy decisions are taken by a homogenous entity, often denoted as ‘the’ central bank. Only fairly recently has it been recognized that the fact that monetary decision-making is collective could have implications for the way policy is conducted. Recent surveys include Fujiki (2005) and Vandebussche (2006). Recent empirical studies on the effects of collective monetary policy decision making include Gerlach-Kristen (2003), Meade and Sheets (2005) and Chappell et al. (2005). Von Hagen and Stüppel (1994), Grüner (1999), Hefeker (2003) and Sibert (2003) investigated the case in which committee members have different preferences which may lead to different voting behavior. However, as argued by Blinder (2004) there may be more causes that lead individual committee members to differ in their (voting) behavior: different models, different forecasts or different capabilities to process information.

The contribution this paper intends to make is to follow up on the remarks of Blinder (2004) and investigate another potential source of voting differences besides preference heterogeneity. We focus on issues stemming from heterogeneity among committee members in terms of the accuracy of their judgment of the prevailing (economic) conditions, and therefore their ability to take the (ex ante) correct interest rate decision. Given this objective, we also employ a different methodology and use models of collective decision-making under uncertainty, as commonly used in the jury literature. In fact, to our knowledge, jury models are as yet not frequently used in the analysis of monetary policy, which makes our paper interesting from a methodological point as well.¹ The third innovation of this paper is that we focus on

¹See Gerlach-Kristen (2006) and Meade and Stasavage (2006) for other applications of

central banks that are organized along federal lines. The US Federal Reserve System (Fed) and the European System of Central Banks (ESCB) are prime examples of such central banks. The key characteristic of monetary policy committees (MPCs) of these central banks is their two-tier or hub-and-spokes nature. That is, we take as a starting point an MPC composed of members representing the center (hub, the Federal Reserve Board or the Executive Board of the ECB) and those representing the regions (spokes, US Federal Reserve Bank Presidents or euro area national central bank presidents). Another characteristic of these federally organized central banks, and indeed an assumption we make in this paper, is that the hub is entrusted with preparing the monetary policy discussions to be held in the MPC. This is the case, either implicitly or explicitly, in the US and the ESCB.² We would argue that the execution of the policy preparation task requires a knowledge base of the hub that is, on average, higher than that of the spokes. Both the Federal Reserve Board and the ECB for example develop, maintain and use macroeconomic and other models of the currency area that provide forecasts under alternative policy scenarios. This is a highly specialistic and expensive activity, which is unlikely to be duplicated to the same extent in the spokes. The task of policy preparation thus requires specialistic expertise and an orientation towards processing macro-economic information that is relatively more prevalent in the hub than in the spokes. This is well-documented for the US. Presidents of the Federal Reserve Banks (the spokes) are selected by the boards of these regional banks, and (6 out of 9) of these board members are appointed by the regions themselves and supposed to represent local

jury models to the analysis of MPCs.

²In the US it is stated implicitly, as the key material to be discussed in the FOMC, such as the Greenbook, is produced by (staff of) the Board of Governors. In the euro area, the task of preparing monetary policy is formally given to the hub (ECB Executive Board), see the Maastricht Treaty.

(banking, industry, agriculture and commerce) interests in mind, see Mayer (2001) and Chappell et al. (2005) for details.³ The thrust of this argument is not so much that there is an informational asymmetry, as the information is fully shared, but rather a difference in information processing methods due to different 'mind sets', using the terminology of Blinder (2004). Naturally, these differences between the hub and the spokes are known to the MPC members.

We will show how variations in the scope of the preparatory task of the hub regarding monetary policy in combination with the above-mentioned differentials influence the voting behavior of MPC members, and thereby the quality of monetary policy. If, as we believe is the case, members of the Board of Governors (ECB Executive Board) are in a better position to identify the 'true' state of the economy from the evidence presented than are other members of the FOMC (Governing Council), our analysis indicates that the hub-and-spokes structure, where the hub prepares interest rate proposals, improves the quality of monetary policy. If not, the reverse will hold and monetary policy will be adversely affected.

The remainder of the paper is organized as follows. We begin in section 2 with a stylized description of the decision-making cycle of a hub-and-spokes MPC. Section 3 presents the consequences of our alternative structures of policy meetings for the quality of monetary policy. Section 4 concludes. Appendix contains formal analysis.

³As Mayer (2001, p. 145) notes, there has been some discussion in the US relating to the fact that the FOMC is seen as: '... a committee that makes the key decisions on ... interest rates with almost half of its members chosen by local boards of directors of whom two-thirds are bankers or bankers' representatives.' Meade and Sheets (2005) analyse and confirm the importance of regional considerations for the US case.

2 MPC policy-making cycle and the members' voting behavior

Our starting point is that the hub in a hub-and-spokes MPC prepares the monetary policy discussions. In order to conduct a formal analysis, it is important to be more precise regarding the decision-making process in our MPC.

The preparation task of monetary policy requires at least that the hub prepares written reports on past and prospective economic and financial developments in the currency area that are sent to all MPC members. This evidence is reviewed before the MPC meeting by all committee members, that is they will be briefed by their respective staff.⁴ At the meeting itself, the hub presents oral reports on the current and prospective business situation in the currency area, on conditions in financial markets, and on international financial developments. After these reports, the MPC discusses the economic situation, with each member giving his or her view or interpretation. The MPC then turns to policy. A first possibility is that each member expresses his or her own views on the state of the economy and prospects for the future and on the appropriate direction for monetary policy. Then each member makes a more explicit recommendation on policy. Finally, the Committee must reach a consensus regarding the appropriate course for policy, based on a vote (using simple majority) on the options that evolved from the preceding discussion. The president/chairman of the MPC usually is the one that

⁴Note that in both the US and in the euro area, the hub is located centrally whereas the spokes are geographically dispersed. The former is therefore located together with the staff that prepared the documentation for the MPC meeting. As a consequence, the hub members can much more extensively question the staff that prepared the meeting documentation on the models, assumptions, methods, etc. that they used than members of the spokes (although all members receive the same documentation).

summarizes and formulates the consensus to be voted on.

A second possibility is based on the view that policy preparation involves not only the hub preparing an analysis of the economic outlook of the currency area, but also preparing an interest rate proposal (or a set of possible options) to be discussed in the MPC. This complicates things, as the timing of the policy proposal in the MPC meeting becomes important for the outcome of the meeting, as we will show below. The proposal can be made by the hub at the end of its reporting of the economic situation and outlook. Alternatively, the hub proposal can be made after a general discussion round on the economic outlook, as part of the policy discussion. In the latter case, the interest rate proposal by the hub may be presented at the end of the policy discussion or at the beginning. It may be voiced by the chair or any other representative of the hub. Finally, the president puts an interest rate proposal for the committee to vote on. The decision is taken by simple majority vote.

The formal analysis is presented in the Appendix to this paper. However, given the fact that jury models are not often used in the economic literature, we give some basic ideas here. It basically is a Bayesian game, i.e. a strategic game with imperfect information.

We model the possibility that committee members interpret the evidence differently by assuming that this interpretation represents a private signal each member receives, that is imperfectly correlated with the true state of the economy.⁵ The economy can be in either of two states: in state a where economic conditions require a change of the policy rate (decision A), in state b where the appropriate decision (labelled decision B) is to keep rates un-

⁵Our setup is a modification of the seminal work of Austen-Smith and Banks (1996) and Feddersen and Pesendorfer (1998) on juries. Persico (2004) offers a comprehensive overview of the related literature.

changed. We think that this binary structure is valid for monetary policy decisions, as it is a priori fairly obvious in what direction interest rates will move, if they were to move. We take the view that the decision regarding the size of the interest rate movement is more of a tactical nature and therefore taken separately (this may be interpreted that the decision to be modelled is a decision regarding the total amount of change in the policy stance, as opposed to the decision as to how to allocate this change intertemporally). We furthermore follow the literature and assume that committee members have identical prior beliefs regarding the appropriate monetary policy stance.⁶ Of course this prior belief may and in general will be modified by the evidence presented in the meeting. The higher the quality of individual interpretation or judgment, the larger the probability that the member receives the correct signal, i.e. in favour of a change in interest rates (signal A) in state a and in favour for unchanged rates (signal B) in state b : $P_i(s_i = A|a) = P_i(s_i = B|b) = q_i$ and $P_i(s_i = B|a) = P_i(s_i = A|b) = 1 - q_i$. We label the q_i as individual judgment.⁷ In terms of the reasons given by Blinder (2004) for heterogeneity of committee members' voting behavior, our judgment differentials between members can be interpreted as stemming from differences in the way the information, or the evidence, on the state of the world is processed.

Each committee member wishes to contribute to the appropriate monetary policy, i.e. the interest rate setting that is called for by the state of the economy. Put differently, she strictly prefers the two appropriate pol-

⁶This assumption is formalised by symmetric priors: $\forall i : P_i(a) = P_i(b) = 0.5$. For an analysis of heterogenous priors, see Li, Rosen and Suen (2001).

⁷In the formal analysis, we assume $0.5 < q_i < 1$. This restriction on individual judgment implies that forming a committee to take the decision is useful. If q_i would be smaller than 0.5, then the decision could actually be taken by tossing a coin. If $q_i = 1$, then one individual would be sufficient to take a perfectly correct decision.

icy outcomes over the two bad ones. Moreover, each member considers an inappropriate change in interest rates as bad as inappropriately leaving the policy stance unchanged. These preferences are represented by the following Bernoulli payoffs for each committee member: $u_i(A|a) = u_i(B|b) = 1$ and $u_i(A|b) = u_i(B|a) = 0$. This utility specification implies that all committee members want to take the correct decision. However, they may have different opinions on what the correct decision actually is, since they have different judgments on the economic conditions. This specification, therefore, does not imply that they all prefer the same interest rate.

Each committee member i chooses a voting strategy that maximizes her expected utility, calculated over all states of the world as well as the actions chosen by other members (since they affect the collective outcome and therefore utility of i). The optimal voting strategy of a rational individual is to vote for the alternative that is more likely to be correct, based on her information set. The latter consists of her own signal, the interest rate proposal made by the hub (if made) which is a common piece of information for all committee members, and the information deduced from the fact that her vote is pivotal. The latter concept is key since a rational utility maximizing committee member i will consider only those situations when her actions (her vote) affects directly her utility from the collective decision, i.e. those situations when her vote is pivotal for the collective outcome.

The collective policy decision is taken at the end of the MPC meeting by simultaneous simple majority voting. As we have discussed above, the interest rate proposal that is put to a vote can arise in several ways. It can be prepared by the hub and (i) presented at the beginning of the meeting or the policy round;⁸ or (ii) prepared by the hub and presented at the end

⁸These two possibilities collapse to one case in our analysis, as we do not formally model the outlook round, i.e. an exchange of information and views other than the most

of the meeting; or (iii) it can be presented at the end of the meeting as a summary of the views voiced by all committee members.

These various meeting structures will lead to different collective outcomes (i.e. monetary policy decisions), since they affect the voting behavior of individual MPC members, as we will now show. Note that in all cases the following constitutes common knowledge among the MPC members: the identities of the hub and the spokes, the fact that the hub is entrusted with preparing the MPC meetings, as well as any systemic difference in judgment between the hub and the spokes.

If the proposal to be voted is the one prepared by the hub, then monetary policy decision-making effectively has two stages. We start by assuming that the proposal represents the majority view of the hub, i.e. it is a result of a simultaneous vote in a pre-MPC meeting. As is shown formally in the Appendix (proof to Proposition 2), it is rational for the hub members to stick to their majority view in the policy meeting. If the hub does not achieve consensus in the pre-meeting, its members will operate and vote individually in the MPC meeting.⁹ A first possibility is that the outcome of the pre-meeting of the hub is presented in the MPC meeting before other committee members - the spokes - reveal their independent judgment. In this case, if the hub presents a policy proposal, it is likely to crowd out private judgment of the spokes; the spokes will follow the proposal. As we show formally in the proof to Proposition 1 below (in the Appendix), this constitutes Bayesian Nash equilibrium behavior, meaning that it is a rational choice stemming from members' desire to contribute to the best possible monetary policy.

preferred interest rate options (which is done in the policy round).

⁹We assume that the hub has an even number of members, so that it can be split. If this is the case, this is explicitly acknowledged by the hub. We furthermore assume that the MPC has an odd number of members, meaning that we have an odd number of spokes.

Proposition 1 *If the interest rate proposal by the hub is presented at the beginning of the meeting, and the judgment of the hub members is, on average, more accurate than the judgment of the spokes, the hub's proposal will be adopted by the committee. This is because other committee members will rationally choose to follow the proposal.*

Intuitively, this is because members wish to follow the best piece of evidence when taking their vote: hence, when they observe the majority proposal made by the hub members, which is a highly accurate signal about the state of the economy, they choose to forego their own judgment and to follow the proposal.¹⁰ Hence the collective outcome is determined by the majority position of the hub.

Another possibility is that the hub's proposal is presented at the end of the meeting. In this case the spokes will have revealed their private views on the interest rate before the proposal is put to vote. As we show formally in the proof to Proposition 2 (in the Appendix), this again constitutes a Bayesian Nash equilibrium. The collective outcome will be then determined by the majority vote of the whole committee, with the hub sticking to its interest rate proposal, if it has formed one.

Proposition 2 *If the interest rate proposal by the hub is presented just prior to the vote at the end of the MPC meeting, then the spokes will rationally choose to truthfully reveal their private views on interest rates in the policy round, before the proposal is put to vote.*

The difference in the voting behavior of the spokes, relative to Proposition 1, stems from the fact that in this case the spokes do not observe the hub's

¹⁰See also the seminal work by Morris and Shin (2002) on the crowding out of private information by a common signal.

proposal before they are asked to reveal their views on the policy options. Hence they have to stick to the only piece of evidence available to them: their own independent judgment.

A final possibility involves the interest rate proposal being made at the end of the meeting, as a summary of views of all MPC members. By then, all committee members have revealed their individual views truthfully and a majority proposal can be identified. All members will support it. Hence the collective outcome is determined by the majority view of the whole MPC.

3 Quality of monetary policy

As shown above, the way the MPC meeting is structured, i.e. the scope of the preparatory task of the hub, has a bearing on the behavior of its members and thus on its outcome. As in our model only one outcome is correct, that means that different meeting structures will result in different quality of monetary policy decisions. We are therefore in a position to investigate the consequences of the various interpretations of the role of the hub in preparing monetary policy decisions on the quality of these decisions.

Figures 1 and 2 below depict these effects, for illustrative parameter choices, such as the size of the hub (m), the size of the MPC ($m + n$), and the degree to which the judgment of the hub and of the spokes is, on average, correct (q_M and q_N). The figures relate the quality of monetary policy, i.e. the conditional probability that the MPC takes the correct decision (vertical axis, P), to the difference in average judgment accuracy between the hub and the spokes (horizontal axis, $\Delta = q_M - q_N$). Solid lines refer to the MPC meeting structured in such a way that the hub's interest rate proposal is made at the beginning of the meeting, dashed lines to a structuring of the

meeting such that the hub's proposal made at the end and dotted lines to the meeting with no a priori prepared proposal. We assume $q_M = 0.8$ and hence the Δ -axis runs from zero (no difference in judgment) to 0.3 (maximum difference in judgment, since $q_N \geq 0.5$). Figure 1 illustrates the case of a large MPC, that is a committee dominated by the spokes ($m = 6$ and $n = 11$). Figure 2 illustrates the case of a small MPC - a committee dominated by the hub ($m = 6, n = 5$).

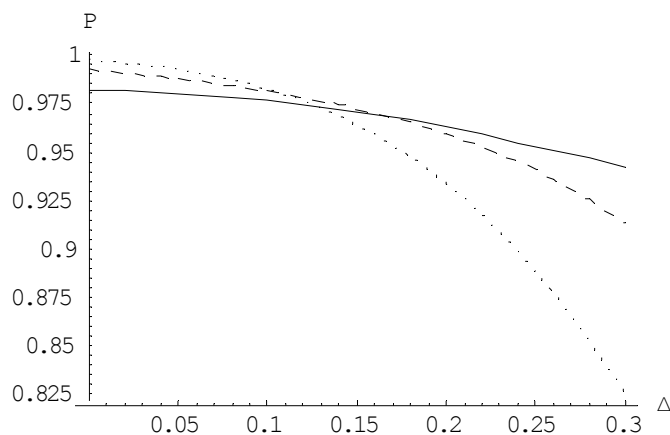


Figure 1. Large committee

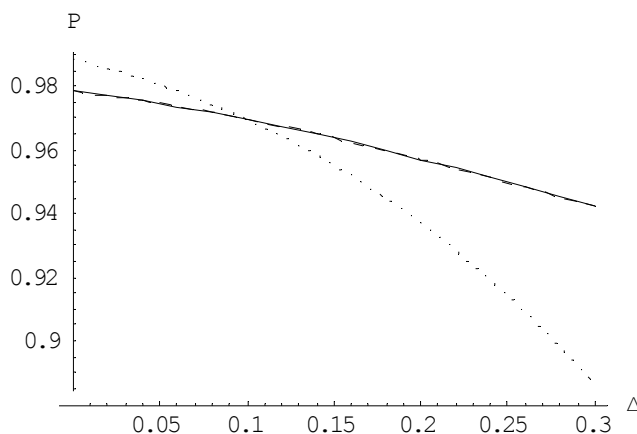


Figure 2. Small committee

If the hub is likely to have a sufficiently better judgment of economic conditions than the spokes, then allowing the hub to prepare the interest rate

proposal to be voted at the end of the MPC meeting improves the accuracy of the collective decision. Consider the FOMC in the United States. This MPC is dominated (in terms of votes needed to secure a majority) by the hub (the Federal Reserve Board) and decides using a simple majority rule. Figure 2 shows that if hub-FOMC members are substantially better in assessing the available evidence on the state of the economy, simple majority without allowing the hub to meet prior to the FOMC meeting¹¹ and to take a common stand on interest rates yields largely inferior results. The loss in accuracy is measured by the distance between the dashed and the dotted lines.

Allowing the hub to present the interest rate proposal at the beginning of the MPC meeting could improve monetary policy even further, if the hub had a substantially better judgment of economic conditions than the spokes. The additional improvement in accuracy is measured by the distance between the dashed and the solid lines. However, this effect will not be observed in a small committee, since it is already dominated by the hub: its interest rate proposal is by assumption adopted by the entire MPC. That is why in figure 2 the dashed and the solid lines overlap.

Let us therefore consider the ECB Governing Council, a large MPC where the Executive Board (hub) is in minority and that decides by simple majority. Figure 1 shows that if - and only if - the Executive Board were on average substantially better in interpreting the evidence on the state of the economy in the euro area than their colleagues from national central banks, the hub should be allowed to make the interest rate proposal at the beginning of the policy meeting. If, on the other hand, the judgment difference is relatively small, it might be still beneficial to have the hub prepare the interest rate

¹¹According to Meyer (2004), such prior meetings of the hub exist, in the form of 'Monday Board meetings', monday being the day before the FOMC meeting.

proposal, but it should be postponed to the end of the meeting.¹² Alternatively, when Council members are nearly identical in terms of their ability to assess the true state of the economy of the euro area correctly from the available evidence, the interest rate proposal should not be prepared prior to the Governing Council meeting but it should represent the majority of views expressed in the meeting.

Extending the task of the hub regarding the preparation of monetary policy discussions to preparing interest rate proposals thus can improve the quality of monetary policy by implicitly reinforcing its position in the MPC. However, a word of caution is necessary. As we have seen, accurate knowledge of the size of the judgment differential is essential, if one were to institutionally adjust the structure of the federal two-tier MPC, i.e. composed of the hub and the spokes, as to achieve the best possible monetary policy decision. A misjudgment might lead to a committee structure that actually results in worse monetary policy outcomes than what will result if nobody prepares interest rate proposals *a priori*. We can observe this in figure 1: for a judgment difference smaller than 0.11 the dotted line is above both the dashed and the solid lines, i.e. an interest rate proposal flowing more or less endogenously from a discussion in which all MPC participate (i.e. no policy proposal by the hub) yields the highest accuracy in collective decision-making.

One could also imagine alternative institutional setups including the spokes' members meeting prior to the vote in the MPC and agreeing on a common position. However, apart from practical difficulties (contrary to the hub, spokes are geographically dispersed), in the presence of a judgment advantage among the hub members, such a set-up would not yield an improvement

¹²This is because the (opportunity) cost of following the proposal, i.e. the spokes giving up their own independent assessment of the economic situation, increases as the judgment advantage of the hub decreases.

in the quality of monetary policy. This is because they would strengthen the influence of the committee members with a lower judgment on the final decision. Also, the MPC vote would become highly sensitive to the relative sizes of the two groups: the position of the larger group would determine the collective decision. It would therefore be advisable to make the hub larger so that their (more likely to be correct) position would prevail. But then, this is exactly the case we have analyzed.

The key idea underlying the analysis presented above is the suggestion of Blinder (2004) that members of MPCs might differ systematically in their ability to interpret the economic evidence presented to them in the committee meeting. This might then interact with decision-making procedures that assign a preparatory task to a part of the MPC (i.e. the hub) to affect the quality of monetary policy. Note that our set-up can be also applied to the situation in which one of the hub members dominates the hub on the basis of his or her relatively superior judgment. This can be interpreted as the situation which many believed was the case in the FOMC under Chairman Greenspan.¹³ Figure 3 below shows the effect of the chairman dominating the hub and, therefore, a small committee. As in figure 2, the MPC consists of 11 members, with a hub of size 6. The dashed line again depicts the outcomes where the hub prepares, using the same simple majority voting rule as before, the interest rate proposal and the dotted line depicts the outcomes with no a priori prepared proposal. The solid line now depicts the case when the hub's position is solely determined by the chairman, whose judgment accuracy is set at 0.9, i.e. the same level as the accuracy of the majority of the hub.¹⁴ Since the chairman dominates the whole committee,

¹³Note that this belief, which was widely shared, corroborates our point that judgment differentials between the hub and the spokes are, by their nature (see the remarks by Blinder, 2004), common knowledge.

¹⁴The probability that at least 4 out of 6 hub members identify the correct decision

the judgment of other MPC members has no effect on the accuracy of the policy decisions: it remains constant at the level of chairman’s individual judgment. We can clearly see that, as Blinder (2006) noted, one should not always put all one’s eggs in one chairman’s basket.

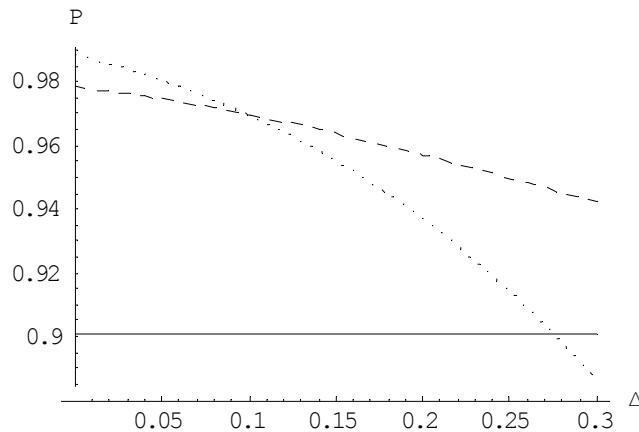


Figure 3. The chairman effect in a small committee

4 Concluding observations

In our view one cannot dismiss a priori the possibility that there is a difference in judgment accuracy between members of the hub and the spokes in MPCs similar in structure to those in the US and the euro area.¹⁵ This paper indicates that, if such a judgment bias is indeed present and substantial in size, maximizing the quality of federal monetary policy dictates that the hub should interpret its task of preparing monetary policy discussions as also providing interest rate proposals. Whether or not the proposal should

equals $\sum_{x=4}^6 \binom{6}{x} 0.8^x (1 - 0.8)^{6-x}$ or 0.9.

¹⁵Ultimately, the existence of such a bias is an empirical question. Unfortunately, an empirical analysis is impossible to do for the euro area, given the fact that minutes and/or voting records of the policy meetings are not published. For the US, Chappell et al. (2005) find no evidence of difference in ‘power’ of Governors and voting Federal Reserve Bank presidents. However, it is difficult to relate this to differentials in judgment, as there is also evidence that such a bias in the US case would not show up in voting records, as dissenting votes are seen as a revolt to the leadership of the chairman (Meyer, 2004).

be presented during the meeting, and if so at what point during the MPC meeting, depends on the size of the judgment bias. Only if the likelihood of a judgment bias is small, should the hub refrain from making interest rate proposals, instead leaving them as emanating from the discussion during the meeting, as an aggregation of the views expressed by all the members.

We would like to conclude by stating that, while the main motivation of this research is based on real life, i.e. the two-tier or 'hub-and-spokes' monetary policy committees of the US Federal Reserve and the ECB, our analysis is highly stylized and contains some important caveats. This should be kept in mind when interpreting our results. An example of such a caveat relates to the political economy of two-tier MPCs. This paper only looks at the economic interpretation of (judgment differentials in) hub-and-spokes committees. The analysis suggests that the first-best solution would be to eliminate any difference in judgment between the hub and the spokes (compare figures 1-3: as one moves from right to left along the horizontal axis, the quality of monetary policy improves) although this might entail an inefficient duplication of tasks, as mentioned at the beginning of this paper. However, the fact is that a two-tier MPC is part of central banks that are organized along federal lines. It has been argued (see Hefeker, 2003) that these central banks and their MPCs reflect a political compromise between regions, that insist on representation, and a board appointed by the central governing body. So it might be the case that judgment differentials are intrinsic to this type of two-tier committees, in the sense that eliminating them would run counter to the federal structure of the central bank. Whether this is actually the case, is an interesting topic for further research. This paper does suggest, however, that if small judgment differential persists, the interest rate proposal to be voted on by the MPC should be presented at the end of the

policy meeting. This ensures that valuable information is not crowded out.

5 Appendix: Formal analysis

Proposition 1. *If the interest rate proposal by the hub is presented at the beginning of the meeting, and the judgment of the hub members is, on average, more accurate than the judgment of the spokes, the hub's proposal will be adopted by the committee. This is because other committee members will rationally choose to follow the proposal.*

Proof. Each committee member i chooses a voting strategy that maximizes her expected utility, calculated over all states of the world as well as the actions chosen by other members (since they affect the collective outcome and therefore utility of i).¹⁶ There are two types of situations that may occur: (1) votes of other committee members will be divided in such a way that one of the alternatives will receive at least the required majority (in our case of simple majority: $\frac{n+m+1}{2}$ or more votes, where m is the (even) number of hub members and n is the (odd) number of the spokes), and (2) votes of other committee members will be divided in an indecisive way (in our case: $\frac{n+m-1}{2}$ votes for decision A and $\frac{n+m-1}{2}$ for decision B). In the former cases, the action (i.e. the vote) of individual i is immaterial for the collective outcome and therefore for her expected utility. In the latter cases, the vote of individual i changes the collective outcome (i.e. is pivotal) and therefore affects directly her utility from the collective decision. This implies that a utility maximizing committee member i will restrict the analysis of her voting strategy to the cases when her vote matters.

Analyzing the game backwards, we start with the choice facing a spokes'

¹⁶See Osbourne (2004) for a further discussion of Bayesian games.

member when she is to cast a vote for or against a change in interest rates. We have assumed that the interest rate proposal she is to vote on represents the majority view of the hub. We formalize the outcome of the hub meeting in terms of probabilities that a certain alternative is selected, conditional on the available information on the state of the economy. The probabilities of the three possible outcomes of the hub meeting: (1) a proposal representing a correct decision (e.g. a change of policy rate in state a : $P(PA|a)$), (2) a proposal representing an incorrect decision (e.g. no change in policy rate in state a : $P(PB|a)$), and (3) no common position (i.e. $P(NP|a)$) are given by:

$$\begin{aligned}
P(PA|a) &= P(PB|b) = \sum_{\substack{S_M \subset M \\ s_M \geq \frac{m}{2} + 1}} \prod_{i \in S_M} q_i \prod_{i \notin S_M} (1 - q_i) \\
P(PB|a) &= P(PA|b) = \sum_{\substack{S_M \subset M \\ s_M \geq \frac{m}{2} + 1}} \prod_{i \in S_M} (1 - q_i) \prod_{i \notin S_M} q_i \\
P(NP|a) &= P(NP|b) = 1 - P(PB|b) - P(PA|b)
\end{aligned}$$

where the sums are taken over all subsets S_M of the set $M = \{1, 2, 3, \dots, m\}$, such that s_M (the number of members in S_M) is at least $\frac{m}{2} + 1$.

In terms of average judgment of hub members, q_M , we can then write conditional probabilities of the hub arriving at either of the three decisions as:¹⁷

¹⁷It has been shown (see Grofman et al. (1983)) that the accuracy of the collective decision taken by a committee where individuals have heterogeneous judgment can be expressed in terms of the average, $q = \frac{1}{n+m} \sum_{i=1}^{n+m} q_i$, if individual judgment q_i are independently drawn from the following (normal) distribution: $q_i \sim N(q, \frac{q(1-q)}{m+n})$. The important assumption here is that the distribution of judgment has second and higher moments that are negligible. This results in a clustering of judgment around the mean and makes the approximation relatively accurate. In our analysis we will use subgroup averages, denoted by q_M and q_N for the hub and the spokes, respectively. Hence, our approximation will by assumption be more accurate than the approximation of Grofman

$$\begin{aligned}
P(PA|a) &= P(PB|b) = \sum_{s_M=\frac{m}{2}+1}^m \binom{m}{s_M} q_M^{s_M} (1-q_M)^{m-s_M} \\
P(PB|a) &= P(PA|b) = \sum_{s_M=\frac{m}{2}+1}^m \binom{m}{s_M} q_M^{m-s_M} (1-q_M)^{s_M} \\
P(NP|a) &= P(NP|b) = \binom{m}{\frac{m}{2}} q_M^{\frac{m}{2}} (1-q_M)^{\frac{m}{2}}
\end{aligned}$$

The outcome of the hub meeting obviously has consequences for the number of other committee members that have to be in favour of each policy alternative in order to get it passed in the MPC. If the hub has identified the correct alternative, then only $\frac{n+m+1}{2} - m$ spokes have to be of the same opinion to pass the correct decision. If the hub has a common position which in fact is the incorrect policy option, then the MPC can still take the correct decision if at least $\frac{n+m+1}{2}$ out of n spokes vote for it. If opinions in the hub are divided, one half of the hub members will vote for the correct alternative, hence it will be adopted if at least $\frac{n+1}{2}$ spokes vote for it as well.

The optimal voting strategy of a rational individual is to vote for the alternative that is more likely to be correct, based on her information set. The latter consists of her own signal (s_i), the interest rate proposal (P) made by the hub which is a common piece of information for all spokes, and the information deduced from the fact that her vote is pivotal.¹⁸ If the

et al. (1983) using one average skill level, since clustering of committee members into two non-overlapping sub-groups results in the reduction of judgment dispersion within the subgroups (relative to the variance in the whole committee), i.e. $\sigma_M^2 < \sigma_i^2$, $\sigma_N^2 < \sigma_i^2$, where $\sigma_i^2 = \frac{1}{n+m} \sum_{i=1}^{n+m} (q_i - q)^2$.

¹⁸The informational content of the fact that i is pivotal is determined by the voting rule. In the case of pure simple majority and equal judgment, being pivotal does not provide additional information, since other votes are equally split. This would not be true under unanimity. Assuming that no change in interest rates is the default option and the change requires unanimity, the only situation when an individual vote would be pivotal is when all other committee members have voted for a change in interest rates. In that case, and assuming that all other committee members have voted informatively, the individual

member's rational voting choices correspond to the signals she has received, we say that the member votes informatively. Informative voting constitutes a rational choice if the following conditions are met:¹⁹

$$P_{i \in N}(b|P, s_i = B, \text{piv}) \geq 0.5$$

$$P_{i \in N}(a|P, s_i = A, \text{piv}) \geq 0.5$$

where

$$P_{i \in N}(b|P, s_i = B, \text{piv}) = \frac{P_i(b)q_N P(P|b)P_{i \in N}(\text{piv}|b)}{(P_i(b)q_N P(P|b)P_{i \in N}(\text{piv}|b) + P_i(a)(1-q_N)P(P|a)P_{i \in N}(\text{piv}|a))}$$

$$P_{i \in N}(a|P, s_i = A, \text{piv}) = \frac{P_i(a)q_N P(P|a)P_{i \in N}(\text{piv}|a)}{(P_i(a)q_N P(P|a)P_{i \in N}(\text{piv}|a) + P_i(b)(1-q_N)P(P|b)P_{i \in N}(\text{piv}|b))}$$

Informative voting constitutes a Nash equilibrium if the above conditions hold when the probabilities are evaluated under the assumption that all other committee members vote informatively.

The vote of a spokes' member is pivotal when the votes of other committee members are split: $\frac{n+m-1}{2}$ votes for a change and $\frac{n+m-1}{2}$ votes against. Such a situation occurs in three cases, depending on the earlier decision of the hub. If the hub has reached a joint proposal, the votes of other spokes have to be split $\frac{n+m-1}{2} - m$ against $\frac{n+m-1}{2}$, while if the hub has not reached any proposal, the member is pivotal if other spokes are split $\frac{n-1}{2}$ against $\frac{n-1}{2}$ (the

should conclude that state a is more likely to be true than state b and therefore should vote for option A . For a more detailed analysis of the effects of unanimous voting rules, see Feddersen and Pesendorfer (1998), Coughlan (2000) and Gerardi (2000).

¹⁹If we denote $r_i = P(b|i$'s information set), then the expected utility from voting B is $u_i(B|b)P(b)r_i + u_i(B|a)P(a)(1-r_i) = P(b)r_i$ and the expected utility from voting A is $u_i(A|a)P(a)(1-r_i) + u_i(A|b)P(b)r_i = P(a)(1-r_i)$. An individual will vote B if $P(a)(1-r_i) < P(b)r_i$, or (if we assume symmetric priors: $P(a) = P(b) = 0.5$), if $r_i > 0.5$.

hub members are already split $\frac{m}{2}$ against $\frac{m}{2}$, see above).

In the case when the hub members have agreed on the interest rate proposal: 'No change' (PB) and assuming that other spokes vote informatively,²⁰ the conditional probabilities are given as:

$$P_{i \in N}(b|PB, s_i = B, \text{piv}) = \frac{q_N P(PB|b) q_N^{\frac{n+m-1}{2}-m} (1-q_N)^{\frac{n+m-1}{2}}}{(q_N P(PB|b) q_N^{\frac{n+m-1}{2}-m} (1-q_N)^{\frac{n+m-1}{2}} + (1-q_N) P(PB|a) (1-q_N)^{\frac{n+m-1}{2}-m} q_N^{\frac{n+m-1}{2}})} \geq 0.5$$

$$P_{i \in N}(a|PB, s_i = A, \text{piv}) = \frac{q_N P(PB|a) q_N^{\frac{n+m-1}{2}} (1-q_N)^{\frac{n+m-1}{2}-m}}{(q_N P(PB|a) q_N^{\frac{n+m-1}{2}} (1-q_N)^{\frac{n+m-1}{2}-m} + (1-q_N) P(PB|b) q_N^{\frac{n+m-1}{2}-m} (1-q_N)^{\frac{n+m-1}{2}})} \geq 0.5$$

The same conditions define the optimal strategy of the individual in case the interest rate proposal is 'Change interest rates' (PA), since the setup is symmetric, i.e. $P_{i \in N}(b|PA, s_i = B, \text{piv}) = P_{i \in N}(a|PB, s_i = A, \text{piv})$ and $P_{i \in N}(a|PA, s_i = A, \text{piv}) = P_{i \in N}(b|PB, s_i = B, \text{piv})$.

These conditions can be solved to yield the following restrictions on the relationship between average judgment levels and sizes of the two subgroups:

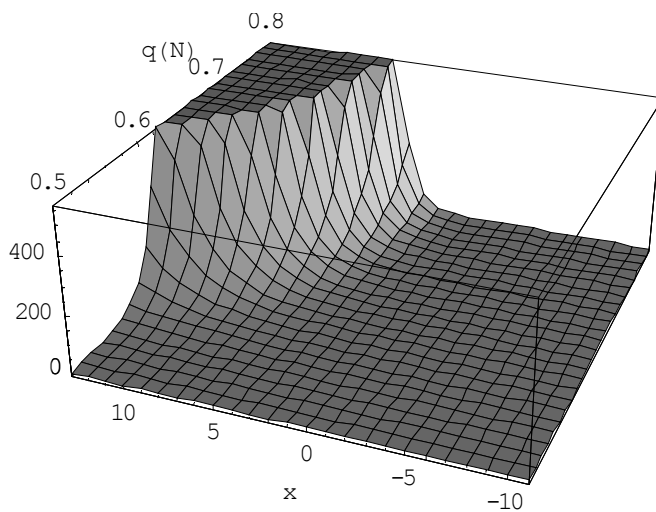
$$\left(\frac{q_N}{1-q_N}\right)^{1-m} \leq \frac{\sum_{s_M=\frac{m}{2}+1}^m \binom{m}{s_M} q_M^{s_M} (1-q_M)^{m-s_M}}{\sum_{s_M=\frac{m}{2}+1}^m \binom{m}{s_M} q_M^{m-s_M} (1-q_M)^{s_M}} > 1$$

$$\left(\frac{q_N}{1-q_N}\right)^{m+1} \geq \frac{\sum_{s_M=\frac{m}{2}+1}^m \binom{m}{s_M} q_M^{s_M} (1-q_M)^{m-s_M}}{\sum_{s_M=\frac{m}{2}+1}^m \binom{m}{s_M} q_M^{m-s_M} (1-q_M)^{s_M}} > 1$$

Obviously, these conditions are not necessarily simultaneously satisfied. First, for $q_N \rightarrow 0.5$, only the first condition will be satisfied, since $\left(\frac{q_N}{1-q_N}\right) \Big|_{q_N \rightarrow 0.5} \rightarrow$

²⁰ And priors are symmetric, as we will assume throughout.

1. Secondly, if q_N increases (and approaches q_M), $\left(\frac{q_N}{1-q_N}\right)^{1-m}$ quickly explodes (as can be seen in the figure below, where the expression $\left(\frac{q_N}{1-q_N}\right)^x$ is drawn as a function of q_N and x) and it becomes increasingly likely that the first constraint will be violated, while the second inequality becomes easily satisfied. By assumption the hub has an advantage in terms of judgment, hence q_N cannot exceed q_M .



We thus have shown, that informative voting when both private and common signals are used by the spokes is not likely to be Nash equilibrium behavior. Nevertheless, this set-up has another equilibrium, where all the spokes ignore their private information and follow the proposal. Under this strategy a single spoke is never pivotal; following the proposal trivially becomes her optimal voting strategy:

$$P_{i \in N}(b|CB, \text{follow}) = \frac{P(CB|b)}{P(CB|b)+P(CB|a)} \geq 0.5$$

$$P_{i \in N}(a|CB, \text{follow}) = \frac{P(CB|a)}{P(CB|a)+P(CB|b)} \leq 0.5$$

Finally, in the last possible case when no consensual position has been reached by the hub, the standard results of Austen-Smith and Banks (1996) apply and the optimal strategy is to vote informatively.

We now turn to the voting strategies of the hub members. Under our assumptions, an individual member is pivotal for the interest rate decision to be taken in the full committee in m cases. In these cases, her vote makes the difference between adopting a common interest rate proposal or not, while the votes of other committee members are split in such a way that a common position of the subgroup wins if it is adopted and the other alternative wins if no common position is adopted.²¹ This requires the following combination of votes: $\frac{m}{2}$ votes for B in the hub and between $\frac{n-1}{2}$ and $\frac{n-m+1}{2}$ votes (thus $\frac{m}{2}$ possible cases) for B among the spokes²² or (symmetrically) $\frac{m}{2}$ votes for A in the hub and between $\frac{n-1}{2}$ and $\frac{n-m+1}{2}$ votes (again $\frac{m}{2}$ cases) for A among other committee members. The table below illustrates this for a 6-member hub where a member is pivotal for the final decision (to be taken by simple majority $\frac{n+7}{2}$):²³

²¹Alternatively, a hub member that has the swing vote in the hub can be pivotal in the MPC as due to her swing vote, the outcome of the vote in the MPC changes.

²²That implies $\frac{m}{2} - 1$ votes for A in the hub and between $\frac{n+1}{2}$ and $\frac{n+m-1}{2}$ among other committee members.

²³The squares highlight the winning majority. It is therefore easy to see, that depending on i voting A or B , the winning alternative changes (i.e. i is indeed pivotal).

Case		Votes for B	Votes for A
	Hub	3	2
1	Spokes	$\frac{n-1}{2}$	$\frac{n+1}{2}$
	i votes B	$n + 6$	0
	i votes A	$\frac{n-5}{2}$	$\frac{n+7}{2}$
2	Spokes	$\frac{n-3}{2}$	$\frac{n+3}{2}$
	i votes B	$n + 6$	0
	i votes A	$\frac{n+3}{2}$	$\frac{n+9}{2}$
3	Spokes	$\frac{n-5}{2}$	$\frac{n+5}{2}$
	i votes B	$n + 6$	0
	i votes A	$\frac{n-1}{2}$	$\frac{n+11}{2}$

Case		Votes for B	Votes for A
	Hub	2	3
4	Spokes	$\frac{n+1}{2}$	$\frac{n-1}{2}$
	i votes B	$\frac{n+7}{2}$	$\frac{n+5}{2}$
	i votes A	0	$n + 6$
5	Spokes	$\frac{n+3}{2}$	$\frac{n-3}{2}$
	i votes B	$\frac{n+9}{2}$	$\frac{n+3}{2}$
	i votes A	0	$n + 6$
6	Spokes	$\frac{n+5}{2}$	$\frac{n-5}{2}$
	i votes B	$\frac{n+11}{2}$	$\frac{n-1}{2}$
	i votes A	0	$n + 6$

Again, informative voting constitutes a rational choice for a hub member

if the following conditions are met:

$$P_{i \in M}(b|s_i = B, \text{piv}) \geq 0.5$$

$$P_{i \in M}(a|s_i = A, \text{piv}) \geq 0.5$$

where

$$P_{i \in M}(b|s_i = B, \text{piv}) = \frac{q_M P_{i \in M}(\text{piv}|b)}{q_M P_{i \in M}(\text{piv}|b) + (1 - q_M) P_{i \in M}(\text{piv}|a)}$$

$$P_{i \in M}(a|s_i = A, \text{piv}) = \frac{q_M P_{i \in M}(\text{piv}|a)}{q_M P_{i \in M}(\text{piv}|a) + (1 - q_M) P_{i \in M}(\text{piv}|b)}$$

The probabilities that a member of the hub is pivotal for the interest rate decision are:

$$\begin{aligned} P_{i \in M}(\text{piv}|a) &= \binom{m-1}{\frac{m}{2}} (1 - q_M)^{\frac{m}{2}} q_M^{\frac{m}{2}-1} \sum_{x=\frac{n-m+1}{2}}^{\frac{n-1}{2}} \binom{n}{x} (1 - q_N)^{n-x} q_N^x \\ &\quad + \binom{m-1}{\frac{m}{2}-1} (1 - q_M)^{\frac{m}{2}-1} q_M^{\frac{m}{2}} \sum_{x=\frac{n+1}{2}}^{\frac{n+m-1}{2}} \binom{n}{x} (1 - q_N)^{n-x} q_N^x \end{aligned}$$

and

$$\begin{aligned} P_{i \in M}(\text{piv}|b) &= \binom{m-1}{\frac{m}{2}} q_M^{\frac{m}{2}} (1 - q_M)^{\frac{m}{2}-1} \sum_{x=\frac{n-m+1}{2}}^{\frac{n-1}{2}} \binom{n}{x} q_N^{n-x} (1 - q_N)^x \\ &\quad + \binom{m-1}{\frac{m}{2}-1} q_M^{\frac{m}{2}-1} (1 - q_M)^{\frac{m}{2}} \sum_{x=\frac{n+1}{2}}^{\frac{n+m-1}{2}} \binom{n}{x} q_N^{n-x} (1 - q_N)^x \end{aligned}$$

Since (it can be shown that) $P_{i \in M}(\text{piv}|a) = P_{i \in M}(\text{piv}|b)$, we have:

$$P_{i \in M}(b|s_i = B, \text{piv}) = q_M \geq 0.5$$

$$P_{i \in M}(a|s_i = A, \text{piv}) = q_M \geq 0.5$$

and informative voting is rational for all hub members. Therefore the (asymmetric) Bayesian Nash equilibrium of the two-stage voting game with the interest rate proposal prepared by the hub is: (1) informative voting of the hub members and (2) informative voting/following the proposal for the spokes.

■

Proposition 2. *If the interest rate proposal by the hub is presented just prior to the vote at the end of the MPC meeting, then the spokes will rationally choose to truthfully reveal their private views on interest rates in the policy round, before the proposal is put to vote.*

Proof. In this case, at the voting stage of the game, all committee members observe all signals, individually for the spokes and collectively, in the form of the interest rate proposal, of the hub. At this point, all members have full information. The decision that will be chosen is the majority of views revealed in the discussion stage.

However, the information set is different when individual spokes decide on revealing their views on the interest rate options. At this stage, an individual spokes' member does not know whether and what interest rate proposal the hub will make and hence she does not know in which pivotal situation she will find herself: with the hub presenting a proposal and the spokes split against it or with no clear position of the hub and the spokes split equally. Hence, contrary to the situation analyzed in Proposition 1, her information set consists only of her own signal and the information deduced from the fact

that her view is pivotal. Again she will vote informatively if:

$$\begin{aligned} P_{i \in N}(b|s_i = B, \text{piv}) &= \frac{q_N P_{i \in N}(\text{piv}|b)}{q_N P_{i \in N}(\text{piv}|b) + (1 - q_N) P_{i \in N}(\text{piv}|a)} \geq 0.5 \\ P_{i \in N}(a|s_i = A, \text{piv}) &= \frac{q_N P_{i \in N}(\text{piv}|a)}{q_N P_{i \in N}(\text{piv}|a) + (1 - q_N) P_{i \in N}(\text{piv}|b)} \geq 0.5 \end{aligned}$$

where

$$\begin{aligned} P_{i \in N}(\text{piv}|b) &= P_{i \in N}(\text{piv}|a) = P_{i \in N}(\text{piv}) \\ &= P(CB|b) \binom{\frac{n-1}{2}}{\frac{n+m-1}{2}-m} \left(q_N^{\frac{n+m-1}{2}-m} (1 - q_N)^{\frac{n+m-1}{2}} \right) \\ &\quad + P(CA|b) \binom{\frac{n-1}{2}}{\frac{n+m-1}{2}} \left(q_N^{\frac{n+m-1}{2}} (1 - q_N)^{\frac{n+m-1}{2}-m} \right) \\ &\quad + P(NC|b) \binom{\frac{n-1}{2}}{\frac{n-1}{2}} q_N^{\frac{n-1}{2}} (1 - q_N)^{\frac{n-1}{2}} \end{aligned}$$

Hence, we arrive at the following simplification of the above conditions:

$$P_{i \in N}(b|s_i = B, \text{piv}) = P_{i \in N}(a|s_i = A, \text{piv}) = q_N$$

By assumption $q_N \geq 0.5$ and therefore the optimal strategy for any member of the spokes is to reveal her views informatively if all other committee members are assumed to vote informatively as well.

Let us now turn to the choices of the hub members. The table below again illustrates the cases when a hub member's view is pivotal for the final decision for a 6-person hub:²⁴

²⁴The squares again highlight the winning majority.

Case		Votes for B	Votes for A
	Hub	3	2
1	Spokes	$\frac{n-1}{2}$	$\frac{n+1}{2}$
	i votes B	$\frac{n-1}{2} + 6 = \frac{n+11}{2}$	$\frac{n+1}{2}$
	i votes A	$\frac{n-1}{2} + 3 = \frac{n-5}{2}$	$\frac{n+1}{2} + 3 = \frac{n+7}{2}$
2	Spokes	$\frac{n-3}{2}$	$\frac{n+3}{2}$
	i votes B	$\frac{n-3}{2} + 6 = \frac{n+9}{2}$	$\frac{n+3}{2}$
	i votes A	$\frac{n-3}{2} + 3 = \frac{n+3}{2}$	$\frac{n+3}{2} + 3 = \frac{n+9}{2}$
3	Spokes	$\frac{n-5}{2}$	$\frac{n+5}{2}$
	i votes B	$\frac{n-5}{2} + 6 = \frac{n+7}{2}$	$\frac{n+5}{2}$
	i votes A	$\frac{n-5}{2} + 3 = \frac{n-1}{2}$	$\frac{n+5}{2} + 3 = \frac{n+11}{2}$

Case		Votes for B	Votes for A
	Hub	2	3
4	Spokes	$\frac{n+1}{2}$	$\frac{n-1}{2}$
	i votes B	$\frac{n+1}{2} + 3 = \frac{n+7}{2}$	$\frac{n-1}{2} + 3 = \frac{n+5}{2}$
	i votes A	$\frac{n+1}{2}$	$\frac{n-1}{2} + 6 = \frac{n+11}{2}$
5	Spokes	$\frac{n+3}{2}$	$\frac{n-3}{2}$
	i votes B	$\frac{n+3}{2} + 3 = \frac{n+9}{2}$	$\frac{n-3}{2} + 3 = \frac{n+3}{2}$
	i votes A	$\frac{n+3}{2}$	$\frac{n-3}{2} + 6 = \frac{n+9}{2}$
6	Spokes	$\frac{n+5}{2}$	$\frac{n-5}{2}$
	i votes B	$\frac{n+5}{2} + 3 = \frac{n+11}{2}$	$\frac{n-5}{2} + 3 = \frac{n-1}{2}$
	i votes A	$\frac{n+5}{2}$	$\frac{n-5}{2} + 6 = \frac{n+7}{2}$

The corresponding probabilities that a member of the hub is pivotal for

the interest rate decision are:

$$P_{i \in M}(\text{piv}|a) = \binom{m-1}{\frac{m}{2}} (1-q_M)^{\frac{m}{2}} q_M^{\frac{m}{2}-1} \sum_{x=\frac{n-m+1}{2}}^{\frac{n-1}{2}} \binom{n}{x} (1-q_N)^{n-x} q_N^x \\ + \binom{m-1}{\frac{m}{2}-1} (1-q_M)^{\frac{m}{2}-1} q_M^{\frac{m}{2}} \sum_{x=\frac{n+1}{2}}^{\frac{n+m-1}{2}} \binom{n}{x} (1-q_N)^{n-x} q_N^x$$

and

$$P_{i \in M}(\text{piv}|b) = \binom{m-1}{\frac{m}{2}} q_M^{\frac{m}{2}} (1-q_M)^{\frac{m}{2}-1} \sum_{x=\frac{n-m+1}{2}}^{\frac{n-1}{2}} \binom{n}{x} q_N^{n-x} (1-q_N)^x \\ + \binom{m-1}{\frac{m}{2}-1} q_M^{\frac{m}{2}-1} (1-q_M)^{\frac{m}{2}} \sum_{x=\frac{n+1}{2}}^{\frac{n+m-1}{2}} \binom{n}{x} q_N^{n-x} (1-q_N)^x$$

Again we have the result:

$$P_{i \in M}(\text{piv}|a) = P_{i \in M}(\text{piv}|b) = P_{i \in M}(\text{piv})$$

and

$$P_{i \in M}(b|s_i = B, \text{piv}) = P_{i \in M}(a|s_i = A, \text{piv}) = q_M$$

Since $q_M \geq 0.5$ informative voting is rational for all hub members, just as it is rational for all spokes. It is therefore also rational for the hub members to stick to their interest rate proposal formed in their prior meeting (if one is formed) in the MPC vote. Hence, informative voting constitutes a Bayesian Nash equilibrium in this voting setup.²⁵ ■

²⁵Note that this game is a variation on the cheap talk games. Hence it has an analogous equilibrium result, i.e. under simple majority voting rules all individuals reveal their 'types' truthfully in the deliberation stage. For an excellent exposition of deliberative voting games, see Gerardi and Yariv (2006).

References

- Austen-Smith, David and Banks, Jeffrey S.** "Information Aggregation, Rationality, and the Condorcet Jury Theorem." *American Political Science Review*, March 1996, 90(1), pp. 34-45.
- Blinder, Alan S.** *The Quiet Revolution: central banking goes modern.* Arthur Okun Lecture. New Haven and London: Yale University Press, 2004.
- Blinder, Alan S.** "Monetary Policy by Committee: Why and How?" DNB Working Paper No 92, De Nederlandsche Bank, February 2006.
- Chappell, Henry W., Jr.; McGregor, Rob Roy and Vermilyea, Todd.** *Committee Decisions on Monetary Policy. Evidence from Historical Records of the Federal Open Market Committee.* Cambridge, MA: The MIT Press, 2005.
- Coughlan, Peter J.** "In Defense of Unanimous Jury Verdicts: Mistrials, Communication, and Strategic Voting." *American Political Science Review*, June 2000, 94(2), pp. 375-393.
- Feddersen, Timothy and Pesendorfer, Wolfgang.** "Convincing the Innocent: The Inferiority of Unanimous Jury Verdicts under Strategic Voting." *American Political Science Review*, March 1998, 92(1), pp. 23-35.
- Fujiki, Hiroshi.** "The Monetary Policy Committee and the Incentive Problem: A Selective Survey." *Bank of Japan Monetary and Economic Studies*, October 2005, 23 (S-1), pp. 37-92.

- Gerardi, Dino.** "Jury Verdicts and Preference Diversity." *American Political Science Review*, June 2000, 94(2), pp. 395-406.
- Gerardi, Dino and Yariv, Leeat.** "Deliberative Voting." *Journal of Economic Theory*, forthcoming.
- Gerlach-Kristen, Petra.** "Insiders and outsiders at the Bank of England." *Central Banking*, August 2003, XIV(1), pp. 96-102.
- Gerlach-Kristen, Petra.** "Monetary policy committees and interest rate setting." *European Economic Review*, February 2006, 50(2), pp. 487-507.
- Grofman, Bernard; Owen, Guillermo and Feld, Scott L.** "Thirteen theorems in search of the truth." *Theory and Decision*, 1983, 15, pp. 261-278.
- Grüner, Hans.** "On the Role of Conflicting National Interests in the ECB Council." CEPR Discussion Paper no 2192, July 1999.
- Hefeker, Carsten.** "Federal Monetary Policy." *Scandinavian Journal of Economics*, December 2003, 105(4), pp. 643-659.
- Li, Hao; Rosen, Sherwin and Suen, Wing.** "Conflicts and Common Interests in Committees." *American Economic Review*, December 2001, 91(5), pp. 1478-1497.
- Mayer, Martin.** *The Fed: The Inside Story of How the World's Most Powerful Financial Institution Drives the Markets*, New York: Free Press, 2001.

- Meade, Ellen E. and Sheets, Nathan D.** "Regional Influences on FOMC Voting Patterns." *Journal of Money, Credit and Banking*, August 2005, 37(4), pp. 661-77.
- Meade, Ellen E. and Stasavage, David.** "Publicity of Debate and the Incentive to Dissent: Evidence from the US Federal Reserve." *Economic Journal*, forthcoming.
- Meyer, Laurence H.** *A Term at the FED: An Insider's View*. New York: HarperBusiness, 2004.
- Morris Stephen and Shin, Hyun Song.** "Social Value of Public Information." *American Economic Review*, December 2002, 92(5), pp. 1521-34.
- Osborne, Martin J.** *An Introduction to Game Theory*. New York and Oxford: Oxford University Press, 2004.
- Persico, Nicola.** "Committee Design with Endogenous Information." *Review of Economic Studies*, January 2004, 71(1), pp. 165-191.
- Sibert, Anne.** "Monetary Policy Committees: Individual and Collective Reputations." *Review of Economic Studies*, July 2003, 70(3), pp. 649-665.
- Vandebussche, Jerome.** "Elements of Optimal Monetary Policy Committee Design." IMF Working Paper No. 06/277, December 2006.
- von Hagen, Jürgen and Süppel, Ralph.** "Central Bank Constitutions for Federal Monetary Unions." *European Economic Review*, April 1994, 38(3-4), pp. 774-82.