Designing Decision-Making Procedures in MPCs: The Advantage of Premise-Based Decisions*

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Abstract

We study the relevance and implications for monetary policy of a judgment aggregation problem called the 'discursive dilemma'. The dilemma implies that the interest rate decision depends on whether the MPC votes directly on the interest rate (conclusion-based procedure), or reaches decisions through voting on the *premises* for the decision (premise-based procedure). We find that the two decision-procedures are likely to give non-negligible differences in policy. Normatively, our results suggest that a premise-based procedure tends to give better decisions unless uncertainty is strictly additive, in which case the two procedures are normatively equivalent. MPC ownership of the inflation reports and a 'core model' are institutional devices that support premise-based policy decisions.

Keywords: Monetary policy committees, Judgment aggregation, Discursive dilemma

JEL Classification: E52, E58, D71

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1 Introduction

Recently, a new kind of aggregation inconsistency has received much attention in the social choice literature. The inconsistency is sometimes called the 'discursive dilemma', and can be illustrated by the following example. Suppose that the Monetary Policy Committee (MPC) of a central bank discusses whether to perform a sterilized intervention. All MPC members agree to perform the intervention if and only if (i) the currency is misaligned (over-/undervalued), and (ii) sterilized interventions is an effective tool for affecting the exchange rate. The MPC consists of nine members, and their judgments are as in Table 1.

Table 1: Example of the discursive dilemma in the binary case

	Currency misaligned?	Interventions effective?	Intervene?
Member 1 - 3	Yes	No	No
Member 4 - 6	No	Yes	No
Member 7 - 9	Yes	Yes	Yes
Majority	Yes	Yes	No

With these judgments the intervention is rejected by a majority. However, this is not consistent with the majority's judgments on the premises for this conclusion; a majority considers the currency to be misaligned, and a majority believes that interventions are effective. Hence, there is a majority for accepting the premises for interventions, including the decision-rule, but not for actually performing the interventions. There is thus an aggregate inconsistency. Moreover, the inconsistency makes the decision depend on the decision procedure. A *conclusion-based procedure* (CBP), where the MPC votes directly on the conclusion, gives a different decision than a *premise-based procedure* (PBP), where the MPC first votes on the premises and then let the conclusion follow from the decision-rule. The MPC therefore faces a (discursive) dilemma with respect to the choice of decision procedure.

The conclusion and the premises in the above example was binary (yes/no). A similar aggregation inconsistency arises when groups aggregate judgments on non-binary variables. Consider, for instance, an MPC that agrees to set the interest rate according to the classical Taylor rule

$$i_t = r_t^* + \pi^* + 1.5(\pi_t - \pi^*) + 0.5y_t$$

where i_t is the nominal interest rate, r_t^* is the neutral real interest rate, π^* is the desired rate of inflation (inflation target), π_t is actual inflation, and y_t is the output gap. The neutral real interest rate r_t^* and the output gap y_t are uncertain, particularly in real time, and the MPC members must use judgment to quantify them. Suppose that π_t can be perfectly observed, and

Table 2: Example of the discursive dilemma in the non-binary case

	Inputs		Interest rate
	r_t^*	y_t	i_t
Members 1 - 3	2.0	1.0	4.5
Members 4 - 6	2.5	0.0	5.0
Members 7 - 9	2.0	0.0	4.0
Majority	2.0	0.0	4.5

for simplicity assume that inflation is on target, $\pi_t = \pi^* = 2$. Suppose that the MPC has 9 members with estimates as in Table 2.

Let the MPC aggregate judgments by majority voting and let the outcome of the vote be the median judgment. Then the conclusion-based procedure gives $i_t = 4.5$, while the premise-based procedure gives $i_t = 4.0$. The median judgment on the interest rate is thus inconsistent with the median judgments on the inputs, and the actual decision depends on the decision procedure, and there is a discursive dilemma.

Is this discursive dilemma relevant for monetary policy? Should a monetary policy committee use a premise-based procedure or a conclusion-based procedure? The aim of this paper is to answer these questions. Our analysis will be based on the standard New Keynesian model. We allow the MPC members to disagree on the size of shocks, parameters, and preferences.

We find that the dilemma is indeed relevant for MPC decisions. The probability for the dilemma is high, and it matters which procedure the MPC uses. Furthermore, a premise-based decision procedure gives better outcomes than a conclusion-based decision procedure. Our results therefore suggest that there are gains from making monetary policy decisions more premise-based than they appear today. One way to achieve this is to let the interest rate decisions follow from a *core forecasting model* and the *inflation report*, which together represent the MPC's aggregate judgments on the economic mechanisms and the "shocks". We discuss this issue in more detail in section 4.

As indicated above, our analysis relates to the recent literature on judgment aggregation in addition to the literature on monetary policy and MPCs. In the literature on judgment aggregation, researchers consider the aggregation of judgments on interconnected propositions. The early contributions considered concrete examples like in the example of Table 1. More recently, researchers have build general social choice theoretic models of judgment aggregation. The first example is List & Pettit (2002) who also provided the first impossibility result. Their result was quickly followed by several stronger impossibility results and possibility results, see Dietrich (2007) for an overview. Roughly speaking, the impossibility results say that if the propositions under consideration are interlinked, then there exsist

no aggregator that fulfil requirements similar to, but not exactly equal to, the Arrowian requirements that aggregate consistent individual judgments on propositions into consistent collective judgments on these propositions. Claussen & Røisland (2007b) provide impossibility and possibility results for the aggregation of judgments on dependent variables. List (2005) and Bovens & Rabinowicz (2003) study the relevance of the discursive-dilemma types of inconsistencies for the aggregation of judgments on propositions. There is no study of the relevance of the inconsistency when aggregating judgments on variables. To our knowlege the relevance of the discursive dilemma for monetary policy has not been studied before. Actually, the discursive dilemma and the aggregation inconsistency giving rise to the dilemmas seems to be largely unrecognized by both researchers and practiononars of monetary policy.[1]

The paper is organized as follows: In section 2, we analyze and characterize the differences between the two procedures and when the discursive dilemma may occur. In section 3, we investigate normative issues, in particular which of the two procedures gives the better monetary policy decision. Based on the results in section 3, we discuss in section 4 the implications of our findings for institutional design. Section 5 summarizes the results and points out issues for future research.

2 Positive analysis

2.1 An impossibility result

We will first give the impossibility result that forms the basis for our analysis. Consider a group (e.g. an MPC) with three or more members, where n denotes the number of members. The group has to estimate the value of a conclusion variable c (e.g., the key interest rate) when the value of c depends on k premise-variables $p_1, ..., p_k$ by a *decision rule*

$$c = f(p_1,p_2, ..., p_k).$$

Denote individual j's estimate of the conclusion-variable c_j, and his estimate of premise-variable i by p_{ij}. The individual estimates are assumend to be consistent with the decision rule such that

$$c_j = f(p_{1,j}, p_{2,j}, ..., p_{k,j}) \quad \forall j \in \{1, 2, ..., n\}.$$

We consider the case when the group aggregate by performing a pairwise vote over the alternatives for each variable. With single-peaked preferences,

[1] Faust & Henderson (2004) have, however, a brief discussion of multi-stage decision-making, which is equivalent to our definition of a premise-based procedrue. They write: "There is no theorem on public decisionmaking stating that the multistage decisionmaking approach is good for society."

which is a reasonable assumption for monetary policy decisions, the median is the outcome of such a vote. Denote the aggregate estimate of the conclusion variable and the premise variables for c_A and $p_{i,A}$ respectively, i.e.[2]

$$p_{i,A} = median(p_{i,1}, p_{i,2}..., p_{i,n})$$

and

$$c_A = median(c_1, c_2, ..., c_n).$$

There is a *discursive dilemma* if the aggregate estimates do not respect the decision rule, i.e., if

$$c_A \neq f(p_{1,A}, p_{2,A}, ..., p_{k,A}).$$

From the second example in the introduction we know that there can be a dilemma if there are two premise variables and the decision rule is linear in these variables. Claussen & Røisland (2007b) show that a discursive dilemma can occur if there are more than one premise-variable regardless of the functional form of the decision rule. Furthermore, they show that there can be a dilemma if there is only one premise-variable and the decision rule is non-monotonic. Formally,

Proposition 1 *A discursive dilemma can occur if and only if at least one of the following two conditions are fulfilled*

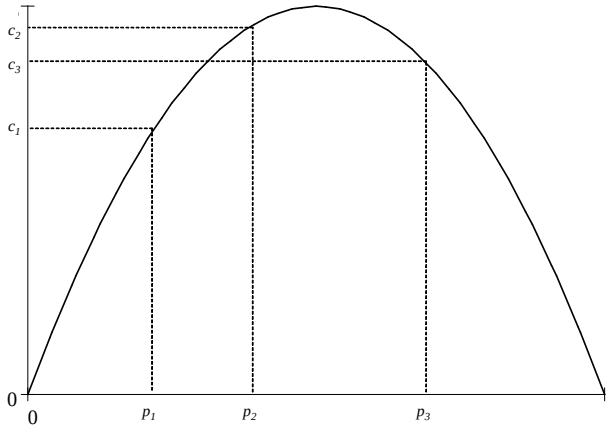
(i) $k > 1$

(ii) $f(p)$ *is non-monotonic.*

Proof. Claussen & Røisland (2007b) ■

To illustrate *case (ii),* assume that $f(p) = p(1-p)$. The function is illustrated in figure 1 (for $0 \leq p \leq 1$). Suppose that the MPC consists of three members with the judgments on p as in the figure. The median of the conclusion-variable is c_3, but this decision is inconsistent with the median judgment on the premise-variable, which is p_2.

[2] We (implicitly) assume that the group uses the same aggregation method for each variable. Without this 'systematicity'-assumption trivial impossibilities arise, see Claussen & Røisland (2007b).



Non-monotonic decision-rules and the discursive dilemma.

2.2 Monetary policy

We suppose that the objective of the MPC is to maximize an objective function. We let the MPC's objective function be represented by a standard loss function, which might be interpreted as the mandate given to the central bank by the political authorities:

$$L_t = E_t(1-\beta)\sum_{l=0}^{\infty}\beta^l[\pi_{t+l}^2 + \lambda y_{t+l}^2] \tag{1}$$

where π_t is the rate of inflation, and y_t is the output gap. The problem of the MPC is to minimize the loss with respect to its instrument(s), subject to its knowledge of the economy. We treat the short-term nominal interest rate as the policy instrument, and let the economy be represented by a standard New-Keynesian model:

$$\pi_t = \beta E_t\pi_{t+1} + \kappa y_t + u_t \tag{2}$$

$$y_t = E_t y_{t+1} - \alpha(i_t - E_t\pi_{t+1}) + v_t, \tag{3}$$

where equation (2) is the New-Keynesian Phillips curve, where u_t is a "cost-push" shock, for example, stemming from stochastic variations in firms' market power. Equation (3) is a dynamic IS-curve, which can be derived from the Euler equation for an optimal consumption path, where i_t is the short-term nominal interest rate, and v_t is a "demand shock", which could be interpreted as stochastic variations in the natural rate of interest, where the long-run equilibrium real rate is for simplicity set to zero.

As a benchmark, consider first the case where the MPC members have identical judgments. This case is tantamount to the case with a single

policymaker. The first-order condition for optimal time-consistent policy is[3]

$$\kappa\pi_t + \lambda y = 0. \tag{4}$$

In rational expectations equilibrium, the interest rate will be given by

$$i_t = \frac{1}{\alpha}\left[v_t + \frac{\kappa}{\kappa^2 + \lambda}u_t\right]. \tag{5}$$

We will use equation (5) as the reference *reaction function*, although we will modify it slightly below in order to depart from certainty equivalence.

Note the difference between a *reaction function* and what we have called a *decision rule*. The arguments in a reaction function is the (time-dependent) variables which the policy instrument should respond to, i.e., v_t and u_t in our model. The arguments in a decision rule are the premise-variables, i.e., variables/parameters that the MPC members might disagree on. For example, if v_t and u_t can be perfectly observed, they do not enter as arguments in the decision rule, even though they enter as arguments in the reaction function. But if the MPC members disagree about a parameter in the reaction function, say, α, this parameter is an argument in the decision rule. The arguments in the reaction function are distributed across the time dimension, but the arguments in the decision rule are distributed across MPC members at a given point in time.

Generally, disagreement among monetary policymakers could be a result of differences in (i) preferences, (ii) judgments on variables, (iii) judgments on parameters, and (iv) models. In this paper, we focus on (i) - (iii) and assume that the MPC-members have the same view on the structure of the economy, i.e., the 'model' as described above. Thus, based on (5), the potential judgment differences can be in terms of

(i) Variables: v_t and u_t
(ii) Parameters: α and κ
(iii) Preferences: λ

We shall discuss each in turn. But before coming to the discussion notice that an MPC meeting can be thought of as a two-stage process. In the first stage - the deliberation stage - the MPC members share their individual judgments and discuss relevant issues. In the second stage - the decision stage - the MPC decides on the interest rate. During the deliberation stage, the MPC members may adjust their judgments such that they converge to a common judgment, but they may not always reach full consensus. The focus of the paper is not on optimal information pooling or on why members may still disagree after the deliberation stage. We therefore assume that the

[3] Under commitment to the timeless perspective, the level of the output gap is replaced by the change in the output gap, see Clarida et al. (1999).

MPC has been through the deliberation stage, but has not reached full consensus. Most existing theories on the information pooling role of MPCs do not deduct why members still disagree after the deliberation stage. However, Gerlach-Kristen (2003) models the deliberation stage and assumes that the members observe the other members' signal with an error, which explains why disagreement will persist also after optimal Bayesian updating. Other reasons for disagreement can be found in experimental evidence from cognitive psychology showing that people generally do *not* aggregate information in an unbiased manner. One reason for such a bias is overconfidence. We will come back to the implications of overconfidence for the choice of decision procedure in section 3.

2.3 Disagreement about variables

We start with the case when the members disagree about variables only. With the model above and disagreement in v_t and u_t only, (5) gives a linear decision rule:

$$i_t = f(p_1, p_2) = a_0 + a_1 p_1 + a_2 p_2, \tag{6}$$

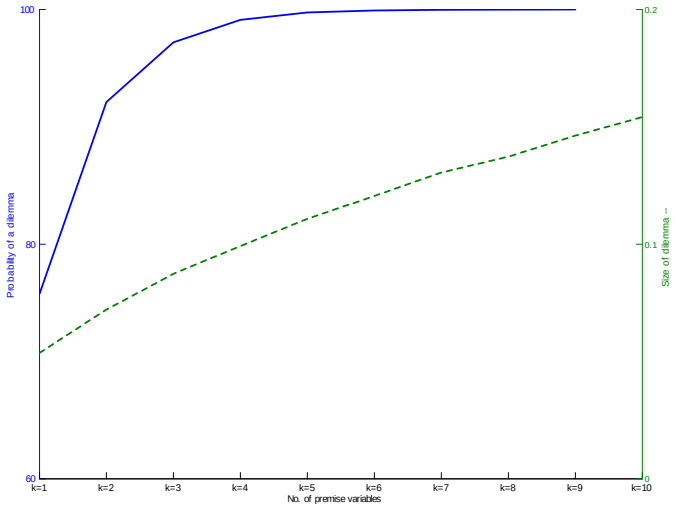
where $a_0 = 0, a_1 = \frac{1}{\alpha}$, and $a_2 = \frac{\kappa}{\alpha(\kappa^2+\lambda)}$. We then have from Proposition 1:

Corollary 1 *There will never be a discursive dilemma if the MPC members disagree about only v_t or u_t.*

Corollary 2 *A discursive dilemma can occur if the MPC members disagree about v_t and u_t.*

We will now look at the likelihood of the dilemma in the case of disagreement on the variables. In order to investigate this, we have performed Monte Carlo simulations on a general linear decision rule $i_t = a_0 + a_1 p_1 + ... + a_k p_k$ under different assumptions about the number of MPC members n, and the number of premise-variables k. In the simulations, we assume that each MPC-member receives an independent stochastic signal of the premise-variables, such that $p_{j,i} \sim N(\overline{p_j}, \sigma_j^2)$, where $\overline{p_j}$ is the true value of the premise-variable. Thus, the individuals have noisy but unbiased judgments.

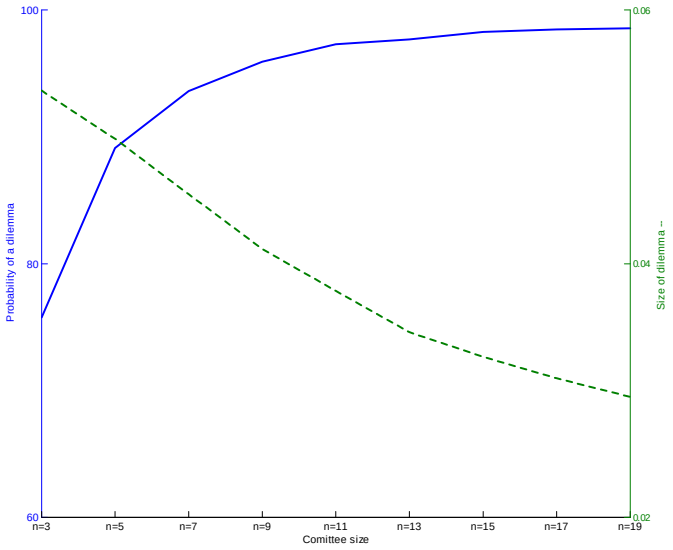
Consider first the case where we vary the number of premise-variables, k. To investigate the relevance of the discursive dilemma, we focus on two moments: the probability that the conclusion-based procedure (CBP) gives a different interest rate than the premise-based procedure (PBP), $P(i^{CBP} \neq i^{PBP})$, and the size of the difference, $\sqrt{var(i^{CBP} - i^{PBP})}$. The simulation results are illustrated in figure 2.



Probability of a dilemma (left axis) and size of the dilemma (right axis) as a function of the number of premise-variables.

We see that the probability of the dilemma is increasing in the number of premise-variables. The intuition for this result is that more premise-variables gives more judgment constellations, such that the probability that the median voter on the conclusion is the same member as the median voter on the premises becomes smaller. We see that the probability of a discursive dilemma is in general close to 100 per cent. This suggests that the discursive dilemma is indeed relevant when there is disagreement about more than one premise-variable. However, the importance of the dilemma does not only depend on the probability, but also on the expected size. The size of the dilemma depends, of course, on the degree of disagreement, which depends on σ_j^2. Note also that the expected size, as measured by $\sqrt{var(i^{cb} - i^{pb})}$, is increasing in the number of premise-variables. This follows from the result that the probability is increasing in k.

For a given set of premise-variables, the probability and size of the discursive dilemma also depend on the size of the committee, i.e., on n. This is illustrated in figure 3. The probability is increasing in n for the same reason that it is increasing in k: more members give more judgment constellations, which reduces the probability that the median voter on the conclusion is the same member as the median voter on the premises. The size of the dilemma is, however, decreasing in n despite that the probability of a dilemma is increasing. The reason is the law of large numbers (Condorcet's Jury Theorem), more than offsets the increase in probability.



Probability of a dilemma (left axis) and size of the dilemma (right axis) as a function of the number of MPC members.

2.4 Disagreement about parameters

We now assume that the the MPC members disagree about the parameters in the model, that is, on α, and κ in (5), but not on the variables. The various parameters enter the reaction function (5) differently, which gives rise to a different functional form of the decision-rule depending on which parameter the MPC members disagree on. We consider each parameter separately.

2.4.1 Disagreement about α

Assume that the MPC members disagree about the effect of the interest rate on aggregate demand, represented by the parameter α in equation (3). The decision-rule becomes

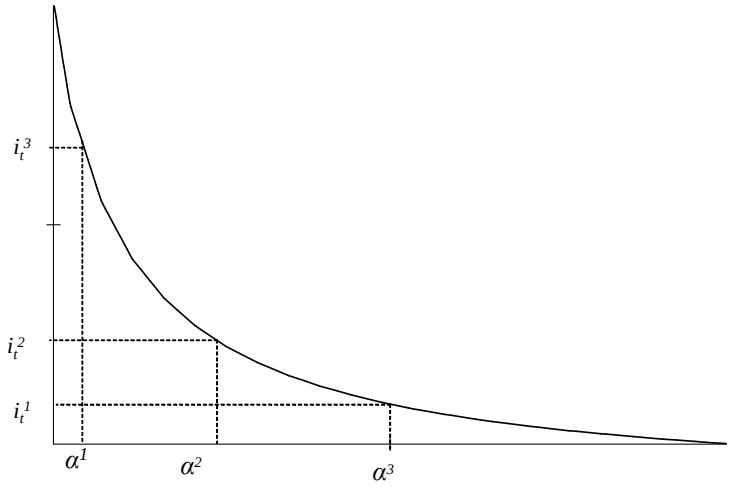
$$i_t = f(\alpha) = a\alpha^{-1}, \tag{7}$$

where $a = v_t + \frac{\kappa}{\kappa^2+\lambda}u_t$. This decision rule is non-linear but monotonic. Thus, together with Proposition 1 we have the following:

Corollary 3 *There will never be a discursive dilemma if the MPC members disagree about α only .*

The corollary (and the decision-rule) is illustrated in figure 4, where we assume that $a > 0$ and that there are three MPC members who have the

judgments α^1, α^2, and α^3.[4]



The decision-rule under disagreement about α

The non-existence of a discursive dilemma under disagreement about α only does not hold if the MPC members are uncertain about their estimates because then the decision rule becomes non-monotonic. This situation is discussed in section 2.6.

2.4.2 Disagreement about κ

Consider then the case where the MPC members disagree only about the slope of the Phillips curve, i.e., κ. Then the decision-rule becomes

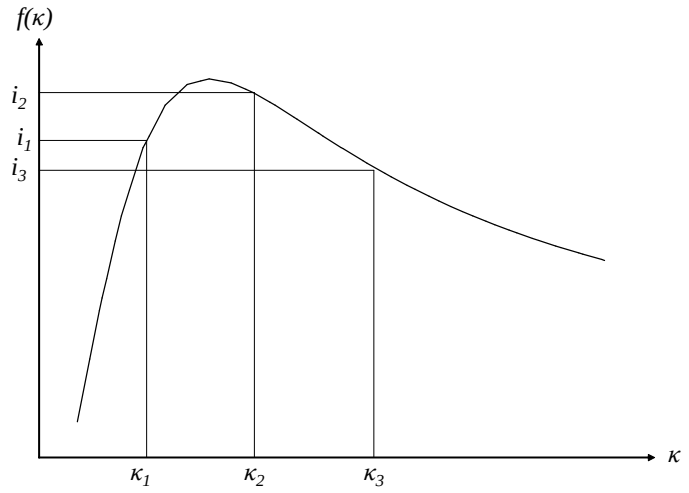
$$i_t = f(\kappa) = a_0 + \frac{a_1 \kappa}{a_2 + \kappa^2}, \tag{8}$$

where $a_0 = \frac{v_t}{\alpha}$, $a_1 = u_t$, and $a_2 = \lambda$. This decision-rule is non-monotonic. Thus, together with Proposition 1 we have the following:

Corollary 4 *A discursive dilemma may occur if the MPC members disagree about κ only.*

The corollary (and the decision rule) is illustrated in figure 5 where there are three members of the MPC with estimates $\kappa_1, \kappa_2, \kappa_3$. The median judgment on the slope coefficient is κ_2, which implies the interest rate i_2, while the median judgment on the interest rate is i_1.

[4] The case with $a < 0$ is the mirror image.



The discursive dilemma under disagreement about κ.

Notice also that since $f(\kappa)$ has only one local maximum, we have that $i^{PBP} \geq i^{CBP}$. Thus, with a discursive dilemma, i.e. when the individual judgmens covers the non-monotonic part of $f(\kappa)$, a conclusion-based procedure gives a more cautious monetary policy than does a premise-based procedure. Formally:

Proposition 2 *With disagreement about κ only,* $\frac{di_t^{PBP}}{du_t} \geq \frac{di_t^{CBP}}{du_t}$

Proof. Let κ^m be the median of $\kappa_{1,}, \kappa_2, ..., \kappa_n$, and $\kappa^{\max}$ and $\kappa^{\min}$ be the highest and lowest value of $\kappa_{1,}, \kappa_2, ..., \kappa_n$. Suppose that $u_t > 0$. We then have that $f(\kappa)$ is increasing in κ for $0 < \kappa < \lambda^{1/2}$, decreasing in κ for $\kappa > \lambda^{1/2}$, and has its maximum at $\kappa = \lambda^{1/2}$. Assume first that $\kappa^m < \lambda^{1/2}$. Then, the $n/2-1$ individuals with judgments $\kappa < \kappa^m$ have $f(\kappa) < f(\kappa^m)$. If $\kappa^{\max} > \lambda^{1/2}$ and sufficiently large such that $f(\kappa^{\max}) < f(\kappa^m)$, it follows that less than $n/2-1$ of the individuals with judgments $\kappa > \kappa^m$, have judgments on $f(\kappa)$ that satisfies $f(\kappa) > f(\kappa^m)$. This implies that the median of $f(\kappa)$ is less than $f(\kappa^m)$, and there is thus a discursive dilemma. If, however, $\kappa^{\max}$ is not sufficiently large such that $f(\kappa^{\max}) > f(\kappa^m)$, it must be the case that $n/2-1$ of the individuals have judgments on $f(\kappa)$ that satisfy $f(\kappa) < f(\kappa^m)$ and $n/2-1$ individuals have judgments on $f(\kappa)$ that satisfy $f(\kappa) > f(\kappa^m)$, such that the median of $f(\kappa)$ is equal to $f(\kappa^m)$. The proof for the case with $\kappa^m \geqq \lambda^{1/2}$ and the case with $u_t < 0$.is paralell. ■

2.5 Disagreement about preferences

Consider then the case where the MPC members differ in their preferences, i.e., on λ in the loss function (1). As mentioned above, recent New-Keynesian

literature derives the utility-based loss function, where λ depends on the deep parameters of the model. In this perspective, disagreement about deep parameters give rise to disagreement about λ. In practice, it is difficult to attribute differences in the members' subjective weights to different judgments on specific parameters of the economic model. We therefore take the traditional view of the loss function, where λ represents the policymaker's preferences, which are assumed independent of his/her judgments on the parameters in the rest of the model.

With λ as the only premise-variable the decision-rule becomes

$$i_t = f(\lambda) = a_0 + \frac{a_1}{a_2 + a_3\lambda}, \tag{9}$$

where $a_0 = \frac{v_t}{\alpha}$, $a_1 = \kappa u_t$, $a_2 = \alpha\kappa^2$, and $a_3 = \alpha$. This decision-rule is monotonic. Thus, together with Proposition 1 we have the following:

Proposition 3 *There will never be a discursive dilemma if the MPC members disagree about λ only.*

2.6 Uncertain MPC members

We assumed above that the MPC members did not take uncertainy into account when forming their desired interest rates. This is a reasonable assumption when there is additive uncertainty since certainty equivalence holds in linear-quadratic models with additive uncertainty. When considering parameter uncertainty, which enters multiplicatively, certainty equivalence does not hold. The above analysis of disagreement about α or κ assumed implicitly that each MPC member was convinced that his/her judgment was the correct one, and did not consider the estimate on α or κ uncertain. It is, however, reasonable to assume that the individual MPC members consider their judgments uncertain and take that into account when forming their preferred interest rates. The MPC members are thus assumed to minimize the loss function (1) conditional on their information and the uncertainty they attach to their estimates. Following the seminal work of Brainard (1967), taking parameter uncertainty into account gives the following reaction function:

$$i_t = \frac{\alpha}{\alpha^2 + \sigma_\alpha^2}\left[v_t + \frac{\kappa}{\kappa^2 + \lambda + \sigma_\kappa^2}u_t\right], \tag{10}$$

where σ_α^2 and σ_κ^2 are the variances of the judgment error in α and κ respectively. As pointed out by Brainard, this type of multiplicative uncertainty gives rise to a more cautious policy response to the shocks.[5]

[5]It should be noted that multiplicative uncertainty does not always give rise to a more cautious policy. For example, Soderstrom (2002) showed that uncertainty about the coefficient on lagged inflation in the Phillips curve gives rise to a more aggressive policy.

The individuals may or may not have the correct perception of the degree of uncertainty. Let $\tilde{\sigma}_i^2$ denote the percieved variance of the judgment error of premise-variable i. Consider first the case where the MPC members only disagree about the size of α, but take parameter uncertainty into account when forming their desired interest rates. This gives the following decision-rule:

$$i_t = f(\alpha) = a_0 + \frac{a_1 \alpha}{a_2 + \alpha^2}, \tag{11}$$

where $a_0 = 0, a_1 = v_t + \frac{\kappa}{\kappa^2+\lambda+\tilde{\sigma}_\kappa^2} u_t$, and $a_2 = \tilde{\sigma}_\alpha^2$. Since this decision-rule has the same functional form as the decision-rule (8), the results from subsection 2.4.2 carry over to this case.

In the case where the MPC members differ in their estimates of κ only, but take uncertainty into account, the decision-rule becomes similar to the decision-rule (8), except that $a_2 = \lambda + \tilde{\sigma}_k^2$ with uncertainty, which makes the interest rate response more cautious. Thus, we may summarize the results under disagreement about α and κ when MPC members take uncertainty into account as follows:

Corollary 5 *If the MPC members take uncertainty into account, a discursive dilemma may occur if the MPC members disagree about α and/or κ.*

The MPC members may also have different perceptions about the degree of uncertainty, i.e. on $\tilde{\sigma}_\alpha^2$ and $\tilde{\sigma}_\kappa^2$. Consider first $\tilde{\sigma}_\alpha$ and suppose for simplicity that the members have the same point estimates of α, but disagree about the degree of uncertainty attached to the estimate. The decision-rule then becomes

$$i_t = f(\tilde{\sigma}_\alpha^2) = \frac{a_1}{a_2 + \tilde{\sigma}_\alpha^2} \tag{12}$$

where $a_1 = \alpha(v_t + \frac{\kappa}{\kappa^2+\lambda+\tilde{\sigma}_\kappa^2} u_t)$ and $a_2 = \alpha^2$. Since (12) has the same functional form as the decision-rule (7), the same results carry over. There is therefore no discursive dilemma.

When the MPC members take parameter uncertainty into account, an important question is how they form their estimate of the degree of uncertainty. The literature on committee decisions, cited in the introduction, and the Condorcet jury theorem suggest that groups make better decisions than individuals. The judgment errors of the MPC as a group are therefore likely to be smaller than for each individual. One may then ask whether the individual members internalize this collective information advantage when forming their estimates on the degree of uncertainty. From a normative perspective, this seems obvious, since it is the MPC as a group that takes the decision, and it is thus the uncertainty attached to the aggregate judgments

that should be taken into account. However, if one takes this argument further, it is hard to see why the members should internalize the collective information advantage and at the same time disagree on the (point estimates) of the parameters. If individual judgment errors are less than perfectly correlated among the members, all judgments have informational value, and it is optimal to take all these judgment into account. From a theoretical point of view, disagreement then seems irrational. However, as argued in section section 2, we do observe that MPC members disagree in practice, and we discussed various reasons for it. Whether it is imperfect ability to "observe" the other members' judgments, as suggested by Gerlach-Kristen (2003), overconfidence, as found in psychological experiments, or other reasons that explains why members do not reach full consensus, it is reasonable to assume that they do not fully internalize the collective information advantage. As we will show in the next section, the assumptions about their estimates of the degree of uncertainty have implications for whether a premise-based or a conclusion-based procedure tends go give better decisions.

3 Normative analysis

In section 3, we demontrated that PBP and CBP may give different conclusions if there is more than one premise-variable on which the MPC members disagree, or if there is one premise-variable and the decision-rule is non-monotonic. Here, we will analyze which of the two decision-procedures that gives the better results, measured by the expected loss, EL_t. A condition for normative dominance of one of the decision-procedures is that PBP and CBP may give different policy outcomes, i.e., that a discursive dilemma may occur. Thus, if the conditions for the existence of a discursive dilemma, as investigated in section 2, are not satisfied, it is trivial to conclude that under these conditions PBP and CBP are normatively equivalent. In our normative analysis, we thus focus only on the cases where the conditions for a discursive dilemma are fulfilled, i.e., that there are either more than one premise-variable, or the decision-rule is non-monotonic. However, even if the two procedures may give different policy outcomes, it does not have to be the case than one of the procedures is on average better than the other.

Since the second-order moments of the median do not have an analytical solution, we compute the expected loss based on Monte Carlo simulations. The simulations are constructed such that n individual estimates are drawn 100 000 times from a known distribution, and the individual estimates are assumed independent and unbiased. For additive uncertainty, we use the normal distribution for the judgment errors, but for parameter uncertainty we use the $beta(\alpha, \beta)$-distribution. The motivation for the latter is that the *beta*-distribution is symmetric, but bounded such that we will always get positive individual estimates. We find it reasonable to assume that even if

the the members disagree on the *size* of a parameter, they agree on the *sign*. For example, all members are assumed to agree that a higher output gap gives rise to higher, and not lower, inflation, i.e., that κ is positive.

3.1 Disagreement about shocks

Consider first disagreements about shocks only, as analyzed in section 2.3. We know from the previous analysis that a discursive dilemma is likely to exist if there is disagreement about more than one shock. With disagreement about both u_t and v_t, we find that the probability density distributions under PBP and CBP are identical and is a linear function of the underlying normal distribution for the individual signals. This also implies that they give the same expected loss and are thus normatively equivalent. This result also generalizes to the case where $k > 2$. Although the normative equivalence between PBP and CBP under a linear decision-rule is somewhat trivial, it represents a benchmark similar to the related certainty equivalence under additive uncertainty. Note, however, that even if PBP and CBP are normatively equivalent and have identical conditional probability distributions for the outcome, the two procedures will still tend to give different decisions on a single MPC meeting, as demonstrated in section 2.3.

Even if PBP and CBP are equal in terms of policy decisions, the difference between the two procedures may raise other challanges. For example, it might be easier for the central bank to communicate monetary policy consistently with PBP. The reason is that central banks normally communicate the reasoning behind a certain interest rate decision. After an interest rate meeting, the central bank thus provides two peaces of information; the interest decision and a 'story', which in this context is the central bank's judgments on the premise-variables. With PBP, the decision is by construction always consistent with the aggregate judgments on the premises. The central bank can then present a 'story' that is both representative for the MPC's views and consistent with the decision. With CBP, the 'story' consistent with the decision is the 'story' believed in by the particular MPC member who was the median voter on the interest rate vote. However, this member's judgments on (some of) the premises will sometimes be far from representative for the MPC's aggregate views on the premises. When the discursive dilemma applies, it is with CBP not possible for the central bank to present a 'story' that is both representative for the MPC's views and consistent with the decision. This issue is further analyzed in Claussen & Røisland (2007a).

3.2 Disagreement about parameters

Before looking at the expected loss, it is useful to consider the conditional probability densisty functions for the interest rate response to shocks. The

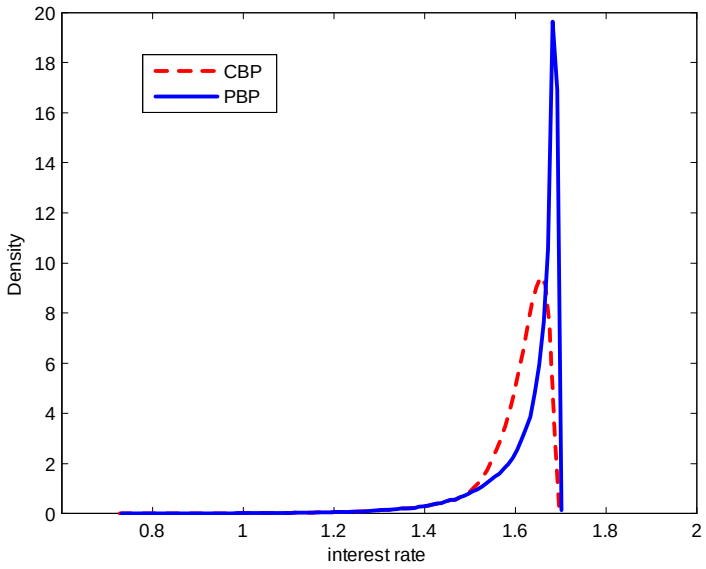


Figure 1: Probability density function under PBP and CBP under disagreement about κ.

interest rate response is stochastic because the median of a finite set of observations is stochastic. Contrary to the case with additive disagreement, the probability distributions of CBP and PBP differ when there is disagreement about parameters. Figure 6 illustrates the probability distribtions when the decision-rule has the form as in equation (8) and (11), under disagreement about κ or disagreement about α when the members take uncertainty into account.

We see that the density distributions for PBP and CBP are different. Two features are worth noting. First, the CBP-distribution is centred somewhat left of the PBP-distribution. This illustrates that the response to shocks tends to be weaker under CBP then under PBP, which we showed in section 2 above. Second, the density function for CBP is thicker than for PBP, which means that the variance of the response coefficeint under CBP is larger than the variance under PBP. The thickness and the location of both distributions depend, however, on the perceived variance of the judgment error, $\tilde{\sigma}_i^2, i = \kappa, \alpha$ (and on λ in the case of decision rule (8)). Larger $\tilde{\sigma}_i^2$ (or λ) lowers both the variance and the mean of the interest rate response to cost-push shocks. Since, as argued above, it is not obvious how the MPC members perceive the degree of uncertainty, we choose to report the expected loss for a range of $\tilde{\sigma}_i^2$.

Since the mean response to cost-push shocks and its variance are differ-

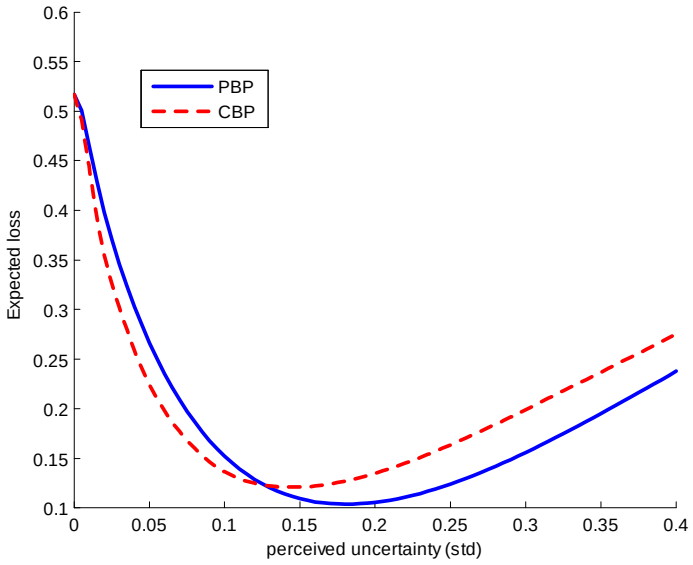


Figure 2: Expected loss under PBP and CBP as a function of perceived uncertainty ($\check{\sigma}_i$).

ent for the two procedures, the expected loss will generally differ. When computing the expected loss we consider the conditional *ex ante* expected loss where we take into account that the true parameter is uncertain.[6]. Consider first the case of disagreement about α. Note that this case is equivalent with disagreement about κ when $\lambda = 0$. The expected loss as a function of the perceived degree of uncertainty, is represented in figure 7.

If the members perceive the uncertainty as very low, i.e., do not take uncertainty sufficiently into account and thus respond to shocks too aggresively, CBP gives lower loss than PBP. The reason is that CBP has a bias towards a more cautios policy than PBP, as shown in section 2.4. If the members have an optimal perception of the uncertainty, we find that PBP is always better than CBP. This result is robust to parameter choices. More-

[6] Under our conditions, the mean of the individual estimates is BLUE, and is the natural aggregate estimator. We thus use the mean and the variance of the mean when computing the expected loss, but at the same time take into account that the MPC uses majority voting. For example, disregarding demand shocks, which are neutralized under both procedures, and assuming that $\alpha = 1$, the expected loss conditional on u_t is equal to

$$E_{u_t} = E_{u_t}[(-\kappa i_t + u_t)^2 + \lambda(-i_t)^2] = (\bar{\kappa}^2 + \sigma_{\bar{\kappa}}^2)i_t^2 - 2\kappa u_t i_t + u_t^2 + \lambda i_t^2,$$

where $\bar{\kappa}$ is the mean of the member's estimates, and $\sigma_{\bar{\kappa}}^2$ is the variance of the mean. The conditional expectation takes into account the different probability distributions for i_t under CBP and PBP.

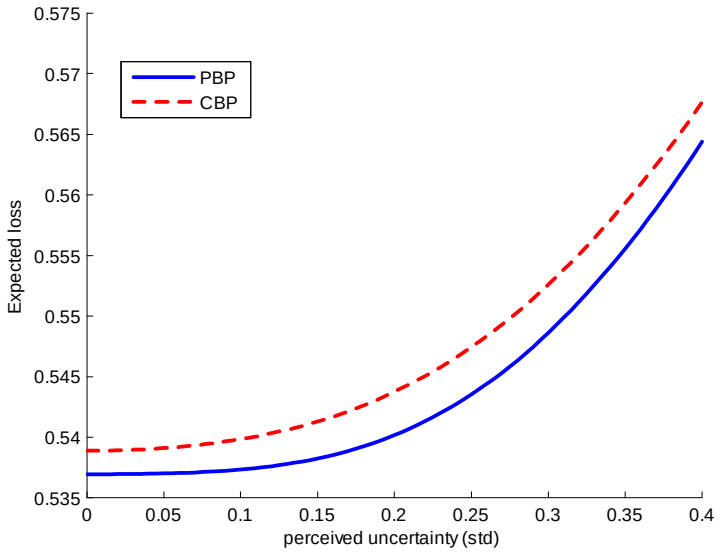


Figure 3: Expected loss as a function perceived uncertainty ($\tilde{\sigma}_\kappa$).

over, if the MPC members are excessively uncertain, PBP is then also better than CBP, because CBP has a bias towards caution. Thus, in the case of disagreement about α, or the special case with disagreement about κ and $\lambda = 0$, CBP can only outperm PBP is a second-best situation where the MPC members are overconfident.

Consider now disagreement about κ when $\lambda > 0$. Unless λ is very small, in which the same qualitative picture as in figure 7 prevails, the performance of the two procedures becomes as illustrated in figure 8.

We see that PBP performs better than CBP for any degree of perceived uncertainty. The reason is that a positive λ cuts off the left part of figure 7, such that only the right part of the curve applies. This can be seen from equation (10), where it is the sum of σ_k^2 and λ that matters for the shape of the decision-rule. This property of the decision-rule has another normative implication. If the MPC members are overconfident, the government can counteract this by specifying a loss function with a higher λ than in the society's loss function. Likewise, if the MPC members are excessively uncertain, the government should specify a lower λ, or, alternatively, appoint (Rogoff) conservative MPC members.

In the above simulations, we have focused on parameter values that tend to give a discursive dilemma, that is, which give judgments that cover the non-monotonic part of figure 5. However, if λ is large and/or the true variance of the judgment errors is small, the judgments tend to be distributed on one of the monotonic parts of figure 5. The discursive dilemma will then

be negligible, and PBP and CBP tend to give the same outcome.

Our interpretation of the overall result in favour of premise-based decisions, is that it is better to aggregate judgments directly on the uncertain variable (or parameter) than to transform the judgment to a conclusion-variable and aggregate on the transformed variable. The decision rule $f(P)$ that transforms the judgments on the premise-variable to the judgment on the conclusion-variable, is an optimal decision-rule, given the estimate of the premise-variable, but it is not derived from the objective of optimal pooling of judgments.

4 Institutional design

The results in section 3 show that a premise-based decision-making procedure tends to give better outcomes than a conclusion-based procedure. This result has institutional implications, since it gives a case for designing institutions that support premise-based decisionmaking. It can be argued that monetary policy decisions are, to some extent, premise-based, as MPCs spend considerable time on discussing premises like the state of the economy and the inflation outlook. However, they vote directly on the interest rate, and it is not reasonable to assume that the individual members feel committed to the aggregate judgment on the premises when voting on the interest rate. This is in particular the case if the MPC members are individually responsible for their interest votes, as are e.g., members of the MPC at the Bank of England.

One potential practical difficulty with implementing a premise-based procedure is discussed by Faust & Henderson (2004): MPC members with different views may have less difficulties of agreeing on and implementing policy directly than agreeing on all the premises for the policy. We find, however, this argument less convincing, since the premise-based procedure does not require that the MPC members *agree* on all the premises. They may agree to disagree, and still reach a collective judgment, for example by majority voting.

A more fundamental problem of a premise-based decision-making procedure is *strategic voting.* The MPC members can manipulate the result of premise-based decision-making by reporting false judgments on the premise-variables. In principle, there is no way of preventing policymakers to act strategically. In practice, however, there is some collective discipline among MPC members that may reduce the scope for strategic voting. Moreover, there exist institutional devices, such as *core models* and *inflation reports.* Minutes from the MPC meetings might also support premise-based decisions if the MPC aggregate its judgmens on the premise-variables, e.g., through voting, and not just report the different individual views. We will discuss these devices in turn.

4.1 Core model

Central banks use models to guide their forecasts and interest rate decisions. Most central banks do not only use one model, but rather a suite of models. The advantage of having a suite of models is obvious. To cite George Box (1979): "All models are wrong, but some are useful". Different models have different strengthes and are useful for different purposes. Although a suite of models approach is advantageous, there is also a danger that each policymaker can "pick a model" to justify his/her judgment on the policy conclusion. Then, the MPC members' preferred interest rates may be based on different models and views on economic mechanisms. In one sense, it is advantageous that policymakers have different views on economic mechanisms, since this may make the monetary policy decisions more robust. However, we have shown that the MPC members should not take their different views on the model the whole way to their interest rate votes, but instead aggregate the views into one "model" representing the MPC's views.

Many central banks have chosen to let one particular model - often called the 'core model' – play a dominant role within the suite of models. The main reason for having a specific core model is probably that it helps coordinating the analysis and forecasting process within the bank. Our results suggest that there is a rationale for having a core model that goes beyond its practical use as a coordination tool: It can be viewed as an institutional device to support a premise-based decision-making procedure. In order to support a premise-based procedure, it is advantageous if the core model is "owned" by the MPC, and not only by the central bank staff.

4.2 Inflation reports

Most inflation targeting central banks publish *inflation reports* (or monetary policy reports). These reports have both an external and an internal role. The external role has to do with providing transparency and accountability, and to manage private sector expectations. The internal role is to provide a common analytical framework for analyzing the state of the economy and forecasting economic developments. An important part of inflation reports is a description and analysis of the current state. In the language of the theoretical model considered in section 4.1, this part of the analysis is to identify and estimate the shocks that have hit the economy. If the inflation report is "owned" by the MPC, and the MPC members have different judgments of the current state of the economy, they have to reach an aggregate judgment of the state in order to present a consistent analysis in the inflation report. The description of the state of the economy in MPC-owned inflation reports can thus be interpreted as the MPC's aggregate judgments on a set of important premise-variables for the interest rate decisions.

In addition to identifying and estimating shocks, the inflation report

presents forecasts of inflation and other macroeconomic variables. The core macroeconomic model plays a key role in the forecasting process. One could argue that when the MPC has agreed on a certain forecast, it has then also agreed on an implicit model, since the forecasts rest on certain assumptions and specifications of the economic process. From the point of view of premise-based decision-making, it may thus not be necessary to agree on a specific core model in addition to the forecasts in the inflation report. It is, however, possible that MPC members can agree on the forecasts, but disagree on the economic mechanisms, since different models, or different calibrations of the same model, can give the same forecast. The implications for monetary policy might, however, be different even if they give identical forecasts.[7] Therefore, inflation reports do not make a core model superfluous as an institutional device for premise-based decisionmaking.

4.3 Premise-based decisionmaking model in practice

It is probably both difficult and impractical to make the decision procedure perfectly premise-based. For instance, it is very time-consuming to reach an aggregate view on each premise-variable in a large set of premise-variables. Moreover, all premise-variables are not always possible to identify and specify in a precise way, which may be required in order to conduct, e.g., majority voting. Realistically, one may talk about a *predominantly* premise-based procedure, where the MPC has aggregated the individual judgments on the most important premise-variables.

One premise-variable that may be difficult to vote on before the actual interest rate decision is how much weight one should attach to stability in the real economy, that is, λ in our model. Most policymakers have judgments or preferences as regard a fair trade-off between conflicting objectives, but in practice the judgments on the appropriate weighing cannot be reduced to voting on a λ. One way to get around this is to have a premise-based procedure on the conditional forecasts, i.e., forecasts based on alternative interest rate assumptions, and let the MPC members vote on the interest rate path that is the one in accordance with his/her judgment on the weighing of objectives. We see from equation (9) that the decision-rule is non-linear, but monotonic in λ. This implies that voting on λ and voting on i_t gives the same conclusion.

To conclude, a our results suggest that a good way to organize interest rate decisions is to have a semi-PBP. First, the MPC should reach an aggregate judgment on the main "economic" premises, that is, the shocks and the "model", and let the staff produce different interest rate paths that reflects alternative weights on stability in the real economy. Then, in the last stage the MPC could use a conclusion-based procedure and vote on the interest

[7] The might, for instance, have different transmission mechansims.

rate (path). Since λ enters the decision-rule monotonically, the discursive dilemma does not apply, and there is no reason to vote directly on λ.

5 Conclusion and issues for further research

In this paper, we have analyzed the relevance of the discursive dilemma for monetary policy decisions in MPCs. We find that the dilemma is indeed relevant, in the sense that it is likely to occur, and likely to be non-negligible in magnitude. Furthermore, we find that under multiplicative (Brainard) uncertainty, a premise-based decision procedure tends to outperform a conclusion-based procedure, partly because the latter gives too cautious policy decisions. The results have implications for how central banks (and other organizations) should organize the decision process. If there is multiplicative uncertainty it will be particularly important to have a *core forecasting model*, which reflects the MPC members aggregate views on the main economic mechanisms, and an *inflation report*, which reflects the MPC members aggregate judgments on the shocks. A core model and inflation reports serve as institutional devices that support a premise-based decisionmaking procedure.

In the paper, we focus on situations where the monetary policy committee aggregate judgments by majority voting. The motivation is that many monetary policy committees seems to use this aggregation method. However, there are also MPCs that claim to aggregate judgments by consensus formation. An interesting extension to this paper would be to study the relevance of the discursive dilemma in situations where the MPC aggregate judgments by consensus formation. To further check the robustness of our results it would be useful to use decision rules derived from other macroeconomic models than the standard New Keynesian model considered here. In addition, it will be interesting to investigate whether our result is robust to other types of multiplicative uncertainty than Brainard uncertainty. For example, is the a premise-based procedure still better if there is uncertainty about the degree of inflation persistence which, as shown by Soderstrom (2002), implies that optimal policy should be more aggressive?

In addition, there is a role for future research in analyzing the relevance of the discursive in other types of collective economic decisions than monetary policy decisions, for example for fiscal policy decisions and for decisions in corporate boards.

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