



ANDREW YOUNG SCHOOL  
OF POLICY STUDIES

# Let Me Vote!

## An experimental study of vote rotation in committees

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### Abstract

We conduct an experiment to investigate (i) whether rotation in voting increases a committee's efficiency, and (ii) the extent to which rotation critically influences collective and individual welfare. The experiment is based on the idea that voters have to trade-off individual versus common interests. Our findings indicate that the choice of a rotation scheme has important consequences: it 'pays' to be allowed to vote, as voting committee members earn significantly more than non-voting members. Hence, rotation is not neutral. We also find that smaller committees decide faster and block fewer decisions. This reduces frustration among committee members.

**Keywords:** Decision-making, committee, experiment, voting, rotation

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## 1 Introduction

Ever since Condorcet started to formally study committees in the 18th century, economists know that committees are efficient tools to aggregate information. At the same time, many people experience that committees lead to endless

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discussions.<sup>1</sup> Hence, ways have been sought to increase a committees' efficiency, that is a committee's ability to reach agreement and maximise the committee members' objective function in a timely efficient way. One such way is the implementation of a rotation scheme, that is to restrict the right to vote on a rotating basis. Little is known what rotation will entail for committee decision-making in practice.

To illustrate the potential consequences of rotation, consider U.S. monetary policy. Monetary decisions are taken by the Federal Open Market Committee (FOMC) of the U.S. Federal Reserve System. The FOMC comprises seven Board members, the President of the Federal Reserve Bank of New York, and four of eleven regional Federal Reserve Bank Presidents. The latter serve one-year terms *on a rotating basis*. Chappell et al. (2004) conclude that the non-voting FOMC members did not significantly influence decision-making in the FOMC.<sup>2</sup> Thus, there is a risk that decisions might be biased towards the individual interests of the persons currently allowed to vote. Rotation may speed up decision-making, but potentially at high social costs if conflicts exist between the common and individual interests. The extent to which such conflicts occur 'in real life' can only be assessed in empirical or experimental studies.

The literature has focused on various aspects of committee decision-making. First, various authors have examined committees' abilities to pool and process information (e.g. Bulkley et al., 2001; Blinder, 2004).<sup>3</sup> Second, the merits of different decision rules have been analysed extensively (see Mueller, 2003), also in situations where conflicting preferences promote manipulation (Li et al., 2001). A third strand of the literature focuses on private versus public information, which enables strategic interaction among committee members. Gerling et al. (2003) provides an overview of studies in this area. Fourth, behavioural economists have studied – among other things – the trade-off between common and individual interests (e.g. Kagel and Roth, 1995).<sup>4</sup>

Experimental studies on rotation or the effectiveness of committee decision-making as defined above are relatively scarce. Waldner et al. (2003) examines the effect of rotation on decisions for the voluntary provision of a public good. In this setup insiders can exclude outsiders from the benefits of the public good.

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<sup>1</sup>'Had Newton served on more faculty committees at Cambridge, his first law of motion might have read: A decisionmaking body at rest or in motion tends to stay at rest or in motion in the same direction unless acted upon by an outside force' (Blinder, 1998).

<sup>2</sup>'The results indicate that non-voting alternates have no appreciable influence over policy outcomes... If policymaking in the FOMC is consensual, that consensus does not appear to encompass the views of non-voting members' (Chappell et al., 2004, p. 418).

<sup>3</sup>Gilligan and Krehbiel (1990) conclude that a committee '...is superfluous if it possesses no special expertise and informational inefficiency is increasing in the uncertainty associated with the policy.'

<sup>4</sup>Beniers and Swank (2004) and Maier et al. (2003) have studied the optimal composition of a committee.

Their results indicate that rotation need not change the provision of the public good, but a strong temptation exists for insiders to exploit outsiders' contribution to the public good by exclusion. Other experimental studies explore the effect of uncertainty on committee decision-making: Blinder and Morgan (2005) find that groups are not more inertial and make better decisions than individuals; similar findings are reported by Lombardelli et al. (2002). Lastly, Abbink (2004) indicates that rotation of staff can be used as a way to fight corruption.

This study differs from previous studies in a number of respects. In our experiment the participants have perfect information, since we are not interested in a committee's ability to pool and evaluate information. This removes possible distortions arising from uncertainty, signalling behaviour etc. Moreover, we provide players with conflicting interests. We investigate the following research questions: Is rotation a useful tool to increase a committee's efficiency? Does the type of rotation scheme matter? Does rotation lead to frustration with negative behavioural consequences? And does a temporary lack of voting power result in 'being ripped off'? To explore these questions we develop an experiment whereby participants have to trade-off private versus common payoffs. Committees consist of five members. We examine three treatments: first, no rotation, i.e. every member is allowed to vote. Second, three out of five committee members are allowed to vote, and every player rotates at the same frequency. Third, one player has permanent voting rights, whereas the other four players rotate at the same speed. In addition, we explore some psychological factors, such as the players' emotions.

Our main findings are the following: Rotation increases a committee's efficiency, but induces distributional effects. The right to vote 'pays off', and voting committee members 'exploit' the non-voting members. Moreover, in committees without rotation decisions are blocked more frequently. As the costs of blocking a decision are high, all rotation schemes outperform a situation without rotation for the committee as a whole. Committee members blocking decisions are punished by other committee members, even though the punishment comes at a cost for the punishing player and is only possible at the very end of the experiment. Lastly, all committee members could have increased their earnings by voting for the option with the highest payoff for the committee as a whole. It seems that by voting for own interests, the players end up in a 'prisoners' dilemma'-like situation, whereby each committee member earns less.

In what follows we discuss the design of the experiment (section 2), before we present our results in section 3. The final section discusses our main findings and applies them to the institutional setting of U.S. monetary policy.

## 2 Experimental design and behavioural considerations

### 2.1 Design

The experiment was set up so that each committee member faces a trade-off between ‘own’ and ‘common’ interests in a full information environment.<sup>5</sup> This reflects that committees as a whole are responsible for the decision taken; yet individual committee members might follow their own (private) agenda. Each committee comprises five members and has to decide between four options.<sup>6</sup> Based on the decision taken each player receives the following payoff:

- Each player earns an *individual payoff* according to his preferences (see example below).
- In addition, each player receives a *common payoff*. The common payoff is the weighted average of the individual payoffs. In calculating the weighted average three players weigh 10 percent each, and two players weigh 35 percent each (one can interpret this as players representing ‘small’ and ‘large’ regions). This payoff ensures that by setting an appropriate policy, welfare gains for the committee as a whole can be generated.

The *total payoff* for each player is the sum of the individual plus the common payoff. The preference structure – determining the individual payoff – of each player is characterized by a single-peaked, symmetric distribution. In each round, the peak of the distribution varies for each region.

Table 1 provides an example. For each option the individual payoffs per region are given by the first five rows. The next row shows the common payoff, that is the weighted sum of the individual payoffs (note that the countries 2 and 5 are given the weight of the ‘large’ regions, i.e. 35 percent each). Finally, the total payoff is given by the sum of the individual plus the common payoff. For example, should option 1 be chosen, the total payoff for player 1 is  $350+265=615$  eurocent. To isolate the effects of rotation and avoid distortions due to imperfect information, we have chosen a full information setting, whereby every player has full information about other player’s incentive structure (i.e. every player receives the information contained in table 1).

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<sup>5</sup>All experimental sessions were run at the Creed Laboratory of the University of Amsterdam. Subjects were recruited online and through announcements on bulletin boards. One experimental session lasted about 2.5 hours and average earnings per subject were 44.4 euro.

<sup>6</sup>Incidentally, Sibert (2005) finds that an optimal monetary policy committee comprises five members. – We use the terms ‘players’, ‘committee members’ and ‘regions’ interchangeably. Note that this interpretation was not given during the experiment. The instructions distributed to the participants (and read aloud by the experimenter) and detailed rotation schemes are available upon request.

		Option 1	Option 2	Option 3	Option 4
<b>Individual payoff</b>	Player 1	350	200	100	25
	<b>Player 2</b>	200	350	200	100
	Player 3	25	100	200	350
	Player 4	350	200	100	25
	<b>Player 5</b>	350	200	100	25
<b>Common payoff</b>		265	242.5	145	83.75
<b>Total payoff</b> (=individual + common payoff)	Player 1	615	442.5	245	108.75
	Player 2	465	592.5	345	183.75
	Player 3	290	342.5	345	433.75
	Player 4	615	442.5	245	108.75
	Player 5	615	442.5	245	108.75

Large countries are in bold print. Weight of small and large countries is 10 and 35 percent, respectively.

Table 1: Example of distribution of payoffs (in eurocent)

In this example player 3, say, faces the following conflict: by voting for option 1 he maximises the common payoff and the payoff for the committee as a whole. However, this option also yields the lowest payoff of all options for himself. Option 4 would maximise player 3's total payoff, but a very low common and total payoff for the committee as a whole. Given these considerations it is not evident for which option player 3 will eventually vote. The peaks of the distribution are chosen in such a way that over all rounds, every player experiences the peak at option 1, option 2 etc. equally often.<sup>7</sup> Hence, we can compare the players' behaviour both across regions and treatments.

Our decision-making procedure mimics the functioning of political committees or international organisations, such as the WTO, the EU Commission or the UN Security Council. Suppose that the committee is to negotiate the text of an international treaty. In practice this entails making different proposals, voting on these proposals, and accepting or rejecting them. This continues until a decision has been reached. In the end, every committee member has to agree with a common text. We capture the most important elements of this procedure, albeit in a stylised manner. We have adopted the following: A sequence of players is randomly determined to make a proposal. This sequence is made public, and the experiment has been set up in such a way that over all rounds, every player gets to make the first, second or third proposal equally often. If a proposal is unanimously supported, it will be implemented.<sup>8</sup> If it is vetoed by any region, the next in the sequence is to make a new proposal, etc. Trans-

<sup>7</sup>An overview of the distribution of the peaks over the rounds is available upon request.

<sup>8</sup>Blinder and Morgan (2005) do not find differences between group decisions made by majority rule and unanimity during an experiment. By imposing unanimity as decision rule we can also investigate the extent to which the outcomes in the experiment differ from the theoretical predictions of majority voting.

lated to the ‘real world’, every proposal can be thought of as either being a new option, or a compromise between different options. In our experiment, every option can only be proposed once and each committee member has the power to veto any given proposal (except one’s own). A similar procedure is used in Fréchet et al. (2003), where bargaining in legislature is studied.

Agreement requires that no one blocks the decision. In the experiment, if four proposals are vetoed, we postulate that the committee cannot reach a decision and each participant is paid 10 eurocent. The payoff if a decision has been blocked is considerably lower than the payoff for ‘the worst possible option’. This coincides with the idea that if, say, the WTO cannot agree on a reduction of tariffs, every participants is worse off. In the experiment – as arguably in real life – every participant knows this in advance.

We investigate three different decision-making schemes (experimental treatments): ‘no rotation’, ‘equal rotation’ and ‘unequal rotation’. Each treatment is run with different participants and is played by 15 groups.

- *No rotation (NR)*: All five committee members vote on all proposals.
- *Equal rotation (ER)*: Only three members are allowed to vote. Regardless of the size of the region all committee members rotate equally often. This implies that every player votes in 60 percent of the rounds.
- *Unequal rotation (UR)*: Only three members are allowed to vote. One large region always votes, the other large region rotates with the same frequency as the small regions (they vote in 50 percent of the rounds).

The rationale behind granting permanent representation to one large region is to investigate whether permanent representation (i.e. knowing that one player will *always* vote and participate in each decision) leads to differences in outcome: As the two large regions differ only that respect, differences in voting patterns or earnings between these two (otherwise identical) regions can be attributed to the permanent representation.

Each committee played 50 rounds under the scheme ‘no rotation’ and ‘equal rotation’ and 48 rounds under ‘unequal rotation’.<sup>9</sup> To counter income effects 10 rounds are randomly chosen at the end of the experiment for paying out. It is important to stress that players are given conflicting incentives as the option yielding the highest payoff differs between players. However, over all rounds, committee members of a given type of region (big or small) face similar

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<sup>9</sup> The number of rounds differs between ER and UR because of differences in the ‘voting cycle’: per voting cycle each player meets all other players the same number of times. The voting cycle is ten rounds (each player meets every other player three out of ten times) under no rotation and equal rotation, but six rounds (each rotating player meets every other rotating member one out of six times) under unequal rotation.

possibilities to ‘earn and exploit’, in the sense that (i) each member experiences equally often the maximal payoff at option 1, option 2, etc., (ii) each member votes an equal number of times,<sup>10</sup> and (iii) each player has similar positions in the voting procedure (i.e. every player has equal possibilities to make the first, second or third proposal).

To check whether the participants understood the instructions each player had to answer some test questions about the experiment before the actual experiment started. To investigate affective responses we used additional tools:

- During the experiment participants were asked to rate their mood on a scale of 1 (very happy) to 9 (very unhappy) after every 10th round (starting at round 5).<sup>11</sup>
- At the end of the experiment, participants reported their emotions by rating the experienced intensity of thirteen different emotions on a 7-point scale (ranging from ‘no emotion at all’ to ‘high intensity of the emotion’). The list includes the following emotions: Irritation, anger, contempt, envy, jealousy, sadness, joy, happiness, shame, fear, surprise, pride, and relief.<sup>12</sup>
- As part of the debriefing procedure all players were given the opportunity to ‘punish’ or ‘reward’ other players. The procedure used was the following. Each player received a lump sum payment of 600 eurocents, which was independent of the earnings in the voting experiment. This payment could be pocketed, or used to reward or punish other players in the player’s group by up to 75 eurocents per player.

Rewarding and punishing came at a cost: each eurocent spent for rewards or punishment cost an additional cent (hence, each player could thus use up to 300 eurocents to reward or punish). In addition, each player could be rewarded or punished by others with a maximum of 300 eurocents.<sup>13</sup>

Lastly, we asked the participants to fill in a questionnaire after the experiment.

## 2.2 Behavioural considerations

Based on economic theory one can think of different hypotheses concerning the participants’ behaviour and the outcome of the experiment:

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<sup>10</sup> The only exception is, of course, one large country under unequal rotation.

<sup>11</sup> ‘Self-report is the most common and potentially the best (...) way to measure a person’s emotional experiences’ (see Robinson and Clore, 2002, p. 934).

<sup>12</sup> Apart from the negative emotions that were expected to be particularly relevant for reciprocity (anger, irritation) some other negative as well as positive emotions were included as filler items, to avoid pushing participants in a particular direction.

<sup>13</sup> In order not to bias their decisions, players were unaware of this possibility during the experiment. Note also rewards and punishments cannot change other participants’ earnings relative to one’s own, hence if they occur, they are likely to reflect emotional factors.

- *Naive voting*: Players are self-interested, but lack any strategic behaviour; they only propose and accept the option that gives the highest total payoff for themselves (i.e. highest common plus individual payoff);
- *Strategic voting*: Players behave like gamesmen maximising their own payoff and behave strategically in proposing options and vetoing them (as is normally assumed in the game theory literature).<sup>14</sup>
- *Median voter decisive*: The preferred option of the median voter is chosen (this option would be chosen under the majority rule);
- *Highest common payoff*: Players do not maximise their own payoff, but the common payoff of the committee.
- *Highest total group payoff*: Maximisation of the sum of the total payoff over all players. This mode also provides a benchmark for how much the group as a whole could have earned (i.e. it can be viewed as maximisation of ‘total social payoff’).<sup>15</sup>

Averaged over all rounds, voting for highest total group payoff also maximises *every* players’ total payoff. Note, however, that in many rounds players have an incentive to deviate from maximising the group payoff by choosing options which maximise their individual (total) payoff. In this respect, the experiment constitutes a prisoners’ dilemma-like situation.

We derived theoretical predictions for the ‘winning option’ for each mode (see appendix). In addition, for strategic voting we also derived the path to the winning option, i.e. from the first proposal to the final decision.

## 3 Results

### 3.1 Does rotation influence earnings?

Arguably the most interesting question is whether or not implementation of a rotation scheme leads to differences in earnings. Are non-voting members right in fearing that they will be ripped off if they are not allowed to vote? In short the answer is: yes. We have two pieces of evidence, between and within treatments.

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<sup>14</sup>Because players have complete information in each round, there exists a subgame perfect equilibrium for each round. Although this equilibrium result may be attainable via different paths, the theoretical outcome is always unique.

<sup>15</sup>Note that in 7 out of 50 rounds the predictions for the mode ‘highest total group payoff’ differ from those for ‘highest common payoff’.

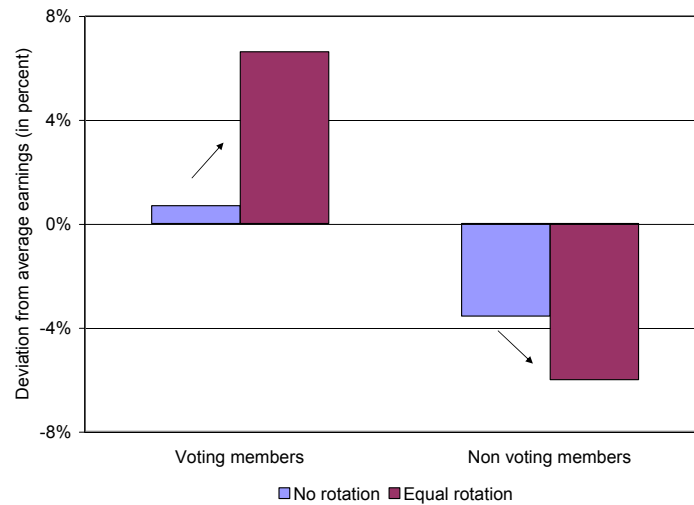


Figure 1: Deviation from av. earnings of voting vs. non-voting committee members (per round)

### Earnings of voting versus non-voting members (between treatments)

We start by comparing the earnings of the voting and the non-voting committee members. Our null hypothesis is that rotation does not change earnings when moving from no rotation to a system of equal rotation; the alternative hypothesis is that (mean) earnings are higher for voting members. Our data rejects the null: Earnings of the voting committee members under equal rotation increase by about 6 percent, relative to earnings of the voting committee members under no rotation, whereas earnings of those committee members that are not allowed to vote under rotation fall by about 2.5 percent.<sup>16</sup> Figure 1 displays the earnings of regions under no rotation and equal rotation, whereby we group the regions into two groups: those that ‘retain’ voting power when the rotation scheme is implemented, and those that lose the right to vote. For those two groups we graph the deviation from average earnings (in percent). We clearly observe the increase in earnings for those that retain voting power, whereas earnings of the non-voting committee members fall. Note that the differences between treatments are also statistically significant at the 1 percent level (two-sided Mann-Whitney test).

Risk averse committee members might not only be interested in average earnings, but also in the variance of their earnings. Figure 1 shows that rotation

<sup>16</sup>Note that outsiders (i.e. those without voting rights) face similar possibilities to earn as those that have retained the right to vote. – As the setup of the rounds in the treatment ‘unequal rotation’ is different from the other two, we cannot directly compare this treatment with the other two.

leads to a higher ‘polarisation’ of earnings, i.e. the difference in earnings between voting and non-voting committee members increases as a result of rotation. After correcting for rounds where no decisions were taken, we find that in the equal rotation treatment the variance of the earnings is significantly higher than in the no rotation treatment.<sup>17</sup> If players are risk-averse, one could imagine that they do not like the higher variability in earnings under rotation. This is not what we find: As we show in more detail in section 3.3, our measurement of emotions does not reveal statistically significant differences in happiness between treatments. Hence, we can reject the hypothesis that relatively higher variability in earnings has negative consequences for (emotional) well-being.

### **Earnings within each treatment**

That having the right to vote pays off is also supported by looking at earnings within each experimental treatment. Comparing average earnings per round, the null hypothesis is that no differences are found between rounds where regions do or do not have the right to vote (the alternative hypothesis is that earnings differ depending on whether or not regions have the right to vote). Again we can reject the null, as earnings increase substantially when one has the right to vote: In the equal rotation treatment, small regions earn 5.4 percent more in that case, while big regions receive a whopping 20 percent extra. In the unequal rotation treatment, earnings of small regions increase by almost 11 percent, and the rotating large country earns almost 15 percent more (earnings in eurocent are displayed in figure 2).

Hence, substantial distributional effects occur between small and large regions. Big regions gain more than small regions when they can vote. On the other hand, they have more to lose if they are not allowed to vote. In the unequal rotation treatment we see a similar pattern, although the differences in earnings between big and small regions are less pronounced.

Lastly, similar results are found when examining differences in earnings between the two big regions. Recall that the two were identical, except that in the unequal rotation case one region was granted permanent voting rights. Comparing earnings within the unequal rotation treatment between the two big regions for rounds in which the rotating region does not have the right to vote (i.e. for 24 out of 48 rounds), we find the ‘permanent in’ region to earn about 7 percent more than the ‘rotating’ region.

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<sup>17</sup>The differences between equal and unequal rotation on the one hand, and no rotation and unequal rotation on the other, are insignificant (Mann Whitney tests, the difference in variation between no rotation and equal rotation is significant at the 1 percent level, the other two are only significant at the 20 percent level).

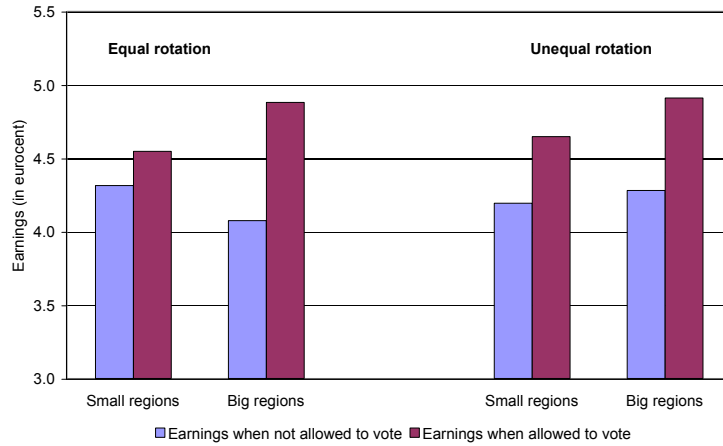


Figure 2: Influence of the right to vote on earnings

### Rotation hardly changes total earnings

Summarising the above, under rotation the voting committee members earn more than the non-voting committee members. Given these distributional effects, one might wonder whether rotation also influences the payoffs of the committee as a whole (i.e. does rotation expand the ‘pie’ or is the ‘pie’ simply distributed in a different way?).

The left part of table 2 reports earnings per player for all three treatments, averaged over all rounds.<sup>18</sup> On average, each player earns 439 eurocent per round in the no rotation treatment. Average earnings are about 2 percent higher under rotation (this difference is significant at the 5 and 10 percent level for equal and unequal rotation, respectively). Given that these differences are economically modest, we conclude that rotation has primarily distributional effects. The effect on total earnings of the committee is only marginal. Further analysis reveals that the differences in earnings across treatments are driven by the fact that less decisions are blocked under rotation.

That said, the maximum average payoff each player could have obtained per round was 492 eurocent. The right part of table 2 indicates how much (on average) could have been gained, had all players simply voted for the option that maximises total group payoff. In the rotation treatments, committee members could have earned almost 10 percent more; without rotation earnings could have been more than 12 percent higher. Additional tests indicate that voting for the option that maximises the total group payoff would have increased earnings of *all* committee members, irrespective of their size. In other words, players do

<sup>18</sup>The term ‘total earnings’ refers to the sum of ‘individual’ and ‘common’ payoff, i.e. the total earning of a player per decision.

All regions	Av. payoff	Possible gain <sup>a</sup>
No rotation	439	12.1 %
Equal rotation	449	9.6 %
Unequal rotation	449	9.6 %

<sup>a</sup>The ‘possible gain’ is the difference between actual payoffs and the payoffs that could have been realised when maximising the total payoff.

Table 2: Earnings per player per round incl. vetoes in eurocent

not simply vote for the option that maximises the total payoff of the committee as a whole. Instead, they vote for own interests, and the committee ends up in a ‘prisoners’ dilemma’-like situation (and each committee member earns less).

### 3.2 Behavioural modes

If, in addition to the findings reported so far, we are able to identify typical behavioural modes, we can better describe the conditions under which the choice of a particular decision-making system might influence the outcome. Suppose, for instance, that all players aim to maximise the committee’s total payoff. In that case the winning option will not be influenced by the composition of the committee. If, however, the participants vote strategically or if the median voter is decisive, then the composition of the committee is indeed a crucial factor in determining the outcome of a decision.

Overall, more than 88 percent of the results is consistent with at least one behavioural mode. In what follows we analyse the extent to which the behaviour of the participants is consistent with the different modes outlined in section 2.2. Unfortunately, this is not as straightforward as it may seem, as in many cases the theoretical predictions yield similar outcomes. We thus have to find ways to distinguish between the various modes. We start by observing that blocking a decision is inconsistent with all behavioural modes. Therefore, in what follows we exclude rounds where the final proposal has been vetoed. Figure 3 shows the percentage of decisions that is consistent with each of the modes considered. It is apparent that naive voting is not very prominent, and maximisation of the common payoff seems to do worse than maximisation of the total payoff. The case for strategic versus median voting is more ambiguous.

As next step we therefore exclude rounds that yield similar predictions. To maximise the number of rounds with different predictions we take the behavioural modes two by two and test which one performs better.<sup>19</sup> Two such tests are displayed in table 3, where we report how many rounds are consistent with the theoretical predictions (in percent). The upper half tests the mode ‘me-

<sup>19</sup>To save space we summarise the main results, additional tests are available upon request.

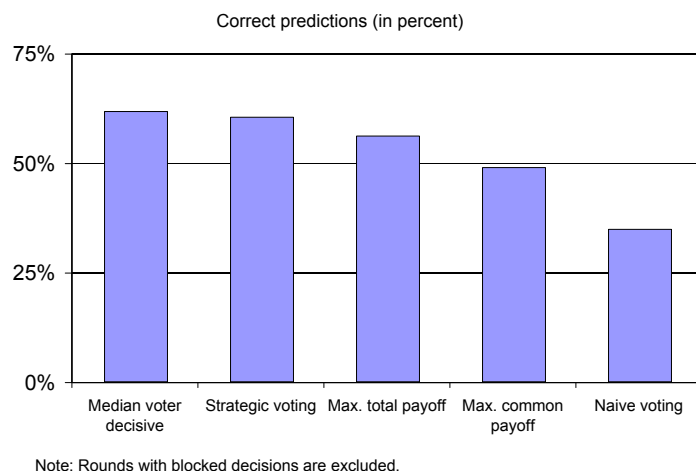


Figure 3: Behavioural modes and outcomes in percent of correct predictions

	No rotation	Equal rotation	Unequal rotation
Median voter decisive	42.9%	56.0%	55.1%
Total payoff	29.7%	27.2%	28.9%
P-value $\chi^2$ test	0.1	0.0	0.0
Median voter decisive	50.4%	-	-
Strategic voting	39.3%	-	-
P-value $\chi^2$ test	0.0	-	-

Note: Only rounds where the strategies differ are considered; rounds with blocked decision are excluded.

Table 3: Testing the behavioural modes (percentage of correct predictions)

dian voter decisive' against 'Maximisation of the total payoff' for those rounds where the outcomes predicted are different. The predictions differ sufficiently to be able to test the two modes in all three treatments. Clearly, maximisation of the total payoff is less frequently employed by the players.<sup>20</sup> The lower half of table 3 compares strategic voting versus the median being decisive. Again, the behavioural mode 'median voter decisive' is the more prominent one, as it is able to explain more decisions than strategic voting (a  $\chi^2$  test reveals that the differences are significant at the 1 percent level). Note, however, that the two modes yield similar predictions in the treatments equal and unequal rotation.

To differentiate between 'median voter decisive' and 'strategic voting' in the rotation treatments, additional evidence is needed. We postulate that for an outcome to be consistent with median voting, the first proposal also needs to be the preferred outcome of the median voter; whereas in the case of strategic voting

<sup>20</sup>Similar results are found when testing the median voter against maximisation of the common payoff.

	No rotation	Equal rotation	Unequal rotation
Median voter decisive	42.5%	43.9%	53.4%
Strategic voting	19.7%	22.1%	21.0%
P-value $\chi^2$ test	0.0	0.0	0.0

Note: Only rounds where the predicted first proposal differs are considered.

Table 4: Median voter decisive versus strategic voting (first proposals, percentage of correct predictions)

the first proposal must be consistent with the theoretical prediction.<sup>21</sup> Table 4 tests the ability of those two behavioural modes to explain the first proposal made in those rounds where both strategies yield different predictions (under the assumptions made). Across all treatments median voting outperforms strategic voting (significant at the 1 percent level). A similar comparison between median voting and maximisation of the total payoff again reveals that median voting explains the participants' behaviour significantly better.<sup>22</sup> Overall, we find that median voting can best describe the committee members' behaviour. This holds irrespective of the voting procedure (treatment). That said, note that median voting is only able to explain about 60 percent of the outcomes.<sup>23</sup> This suggests that either different behavioural modes are mixed over time, or that between or within groups participants follow different modes.

Lastly, finding support for the median as being decisive also implies that if as a result of rotation the median voter changes, distributional effects will occur. Indeed, looking at results for those rounds where rotation changes the median, we find that outcomes change accordingly in 71 percent of the cases. In that regard the results of this analysis correspond with our earlier findings.

### 3.3 Which decision-making procedure is preferable?

As we have seen implementation of a rotation scheme will influence earnings and induce distributional effects. However, there are also other ways to investigate the attractiveness of the various decision-making procedures. In what follows differences across treatments are discussed with regard to how quickly decisions are reached, how many decisions have been blocked, and in terms of rewards and punishment.

<sup>21</sup>Note that in some cases various 'paths' lead to the same outcome. We only look at the 'shortest' path, i.e. the most direct way to obtain the unique subgame perfect equilibrium.

<sup>22</sup>Table 4 seems to suggest that subjects find it easier to behave strategically in the rotation treatments, as computing the backward induction path is easier for committees with three members than for committees with five members. This is, however, not what we find, as there are no statistically significant differences between treatments regarding the first proposals.

<sup>23</sup>Although we have imposed unanimity as decision-making rule about 60 percent of the outcomes are still consistent with majority voting. Note also that if the first proposal is consistent with majority voting this proposal is only vetoed in 36 percent of all cases. This illustrates the 'power' the median voter seems to have.

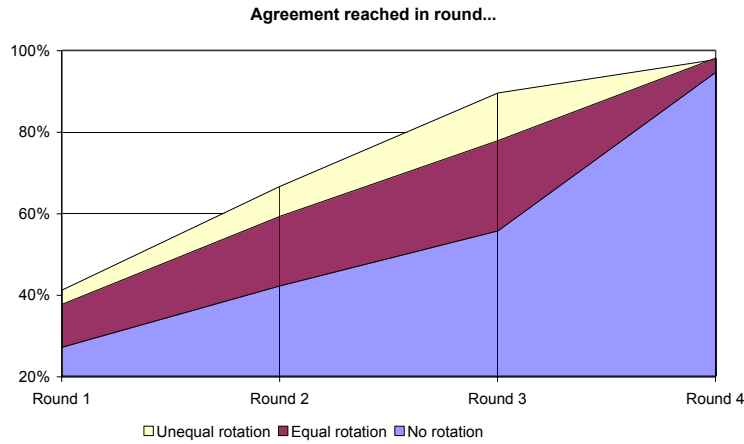


Figure 4: How long does it take to reach a decision?

### Do smaller committees take faster decisions?

To investigate whether rotation speeds up a committee's ability to take decisions we examine how many proposals are made before a decision is reached and how many decisions are blocked.

Figure 4 shows how long it takes to reach a decision. In the first round, agreement was reached in 41.1 and 37.6 percent of all cases under unequal and equal rotation, respectively. In comparison, only 27.1 percent of all proposals were accepted in the first round in the no rotation-treatment. Clearly, with rotation decisions are taken in an earlier phase of the decision-making process compared to no rotation. The difference between no rotation and equal/unequal rotation is also statistically significant. In addition, decisions are taken faster under unequal rotation than under equal rotation.<sup>24</sup> Hence, if fast decision-making is important, our results clearly recommend unequal rotation.

### Why vetoes are important

Interestingly, introduction of a rotation scheme reduces the number of vetoes: Without rotation, it turns out that in 41 out of 750 rounds, decisions are blocked. Under equal and unequal rotation this number is much lower: 15 out of 750 and 17 out of 720 decision rounds, respectively.<sup>25</sup> To check for habituation we plot the number of blocked decisions for each treatment in figure 5. The number of vetoes fluctuates somewhat over time, but there is no statistically significant pattern. Further testing indicates that the relationship between the number

<sup>24</sup>All results are statistically significant at the 1 percent level (two-sided Pearson  $\chi^2$  test).

<sup>25</sup>The differences between NR and ER and between NR and UR are also statistically significant (two-sided Pearson  $\chi^2$  test, all p-values < 0.05).

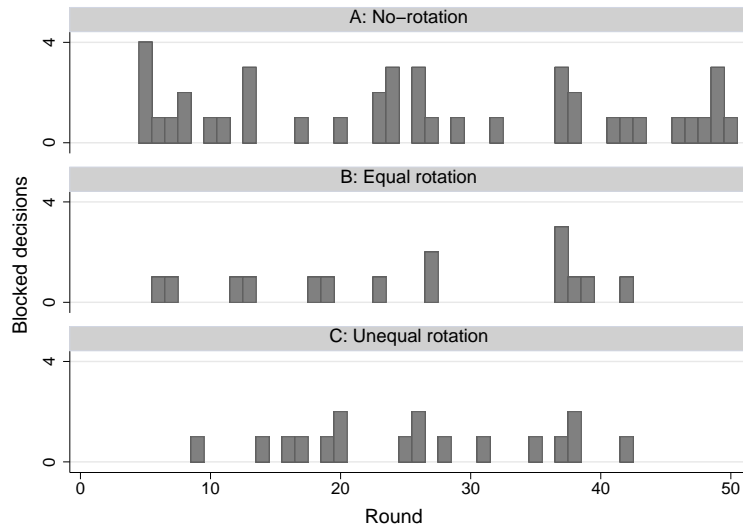


Figure 5: Blocked decisions

of vetoes and the rotation schemes is stable over time. This suggests that committees do not learn to avoid vetoes over time.

These findings raise the question whether the drop in vetoes is the result of having less people on a committee, or whether each committee member becomes less ‘likely’ to veto a proposal. The latter is the case: Without rotation the average committee member vetoes the last proposal with a probability of 1.2 percent. Under equal or unequal rotation this probability drops to 0.71 and 0.79 percent, respectively. Thus, each committee member becomes less likely to block a decision (similar results are found for earlier proposals). Lastly, note that in the unequal rotation treatment the two large regions behave differently: the rotating large region blocks twice as many decisions as the region with permanent voting right (six versus three vetoes).

Regarding the interpretation of blocked decisions, ‘in real life’ not reaching a decision need not always be a bad solution, as the decision to ‘do nothing’ can actually be very wise. But any of the four options can be regarded the decision not to change policy (e.g. keep interest rates stable). This illustrates that blocking a decision is, in this case, really a sign of not reaching an agreement in this round. Moreover, the payoff for blocked decisions is considerably lower than that of every player’s least preferred option. One might argue therefore that it is not economical to veto the last proposal. On the other hand, blocking a decision can be seen as a costly signal to the other committee members that certain options are unacceptable. Emotions such as anger can lead to vetoes, but one can also use vetoes to build up a ‘reputation’ or to ‘punish’ other players.

That fewer decisions are blocked under rotation has two important implications.

- First, it increases players' satisfaction: groups where decisions were blocked are less happy than groups that have always reached a decision.<sup>26</sup>
- Second, vetoes influence the extent to which players wish to punish or reward other committee members at the end of the experiment.

### **Rewards, punishment and emotions**

As mentioned in section 2.1, each player had the opportunity to reward or punish other players in the committee at the end of the experiment. As rewards and punishments occurred at the very end of the experiment, one can think of them as measuring feelings about other players that may persist even when negotiations have ended. Such feelings may be very important in real life committees, as e.g. finding compromises is facilitated if interpersonal relationships are good. Hence, an optimal setup of a committee intends to avoid punishments, as they signal very strong negative feelings about other players.

In total, 51.6 percent of the players made use of the possibility to reward and punish. We find clear evidence that players blocking the decision – i.e. vetoing the last proposal, which leads to ‘no decision taken’ – are punished (see figure 6): players blocking final proposals were on average punished by 26.9 eurocents, while those that did not block a decision were – on average – rewarded by 4.9 eurocents (difference is statistically significant at the 1 percent level). Moreover, the share of players blocking a decision is substantially higher under no rotation than under the two rotation treatments (28 percent of all players blocked one or more decisions under no rotation, whereas only 19 percent of the players blocked decisions under the two rotation treatments). Blocking a decision occurs more often in the no rotation case, and this is regarded as sufficiently negative to make others willing to sacrifice real resources for punishment, even though the experiment has finished. If the negative feelings underlying such behaviour persist, blocking decisions today in a committee could very well have spill-over effects on other issues tomorrow.

Rewards and punishments are not related to total earnings (i.e. it is not the case that ‘low income’ members are supported or ‘high income’ members are punished). Further analysis reveals differences in rewards and punishments between treatments: first, players spend significantly more money to reward or

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<sup>26</sup>Comparing groups in which decisions were blocked with groups where vetoes never occurred, we find that blocking decisions lowers participants' degree of happiness. This effect is found for each of the first three measures of happiness (Mann-Whitney test,  $p=0.001$ ). It is not found in the data collected after rounds 35 and 45. This may be the result of habituation, i.e. players get used to decisions being occasionally blocked. This result is not driven by the number of vetoes, as in the later rounds the number of vetoes does not decrease significantly.

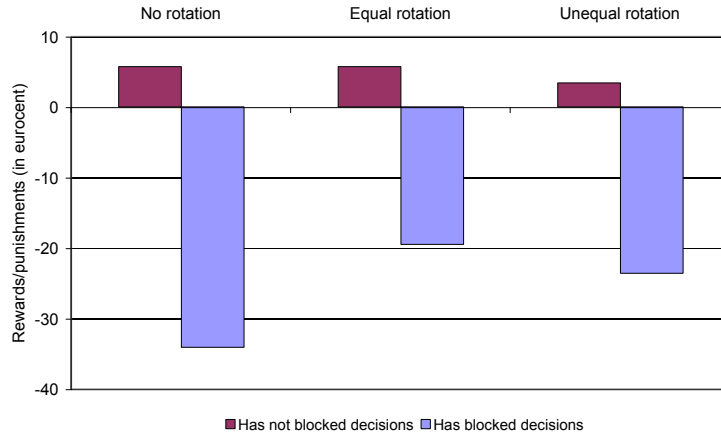


Figure 6: Rewards and punishments

punish without rotation than with equal rotation. Second, slightly more money is spent under unequal rotation than under equal rotation (significant at the 11 percent level). Both findings can be explained as follows: players that do not rotate (i.e. have permanent voting rights) feel a stronger ‘emotional interest’ in the overall distribution of payoffs and have a better view on whom to reward and whom to punish. This shows up nicely in the unequal rotation treatment: distinguishing the two large regions, we find that the region with the permanent seat spends about twice as much on rewards and punishments than the ‘rotating’ large region ( $p=0.09$ , two-sided Mann Whitney test).

As rewards and punishments are costly, they can be interpreted as a sign that strong emotions occur. Since participants had to report their emotions before they rewarded or punished (see section 2.1) we can cross-check with this information. Indeed, we do not find differences in the ‘level’ of emotions between the treatments, but in the extent to which they generate punishments:<sup>27</sup> The results show that three negative emotions (anger, irritation and contempt) significantly influence punishments,<sup>28</sup> but the relationship between negative emotions and punishments is (i) stronger in unequal rotation than in the other two treatments, (ii) stronger for the large region with permanent voting rights than for the rotating large region, and (iii) stronger for the larger regions than for the smaller regions.<sup>29</sup>

<sup>27</sup>As we measure emotions at the end of the experiment, a (theoretical) possibility exists that experienced emotions might differ over time between the treatments.

<sup>28</sup>The correlation between emotion and punishment is 0.25, 0.15 and 0.21 for anger, irritation and contempt, respectively.

<sup>29</sup>Rewarding is less straightforward to interpret. Rewards and emotions are not statistically correlated, and as Sefton et al. (2002) have noticed, rewarding is generally less well-understood

The data on emotions, rewards and punishment can also be interpreted as measures of the attractiveness of the different decision-making procedures. Taken together our results seem to indicate that participants view equal rotation as the ‘fairest’ decision-making procedure, as all participants get to vote equally often. Moreover, as punishments under equal rotation are relatively low, this voting system seems to produce a minimum of frustration among the players.

## 4 Discussion

Our main results can be summarized as follows:

- First, rotation is likely to induce distributional effects. With rotation voting committee members have additional scope to vote in their own interests (as opposed to maximising the group payoff). Consequently, their earnings increase, relative to non-voting committee members. Having permanent voting rights increases the payoff even more.
- Second, all committee members could have increased their (average) earnings by voting for the option with the highest total group payoff. By maximising their own payoff, they get caught in a prisoners’ dilemma-like situation. This effect seems stronger without rotation than with rotation.
- Third, committees that feature a rotation scheme decide faster. Without rotation, committees tend to block decisions more frequently.
- Fourth, there is a positive correlation between blocked decisions and frustrations of players. Players vetoing final proposals get punished, even though this comes at a cost for the punisher and is only possible at the very end of the experiment.

The design of the experiment captures various important aspects of real life committee decision-making (albeit in a highly stylised manner), such as the U.N. Security Council, WTO trade negotiations, or monetary policymaking. Consider the U.S. Federal Reserve System: it is composed of a central ‘hub’ – the Board in Washington – and twelve regional ‘spokes’ (the regional Federal Reserve Banks, which are located throughout the country). The Federal Open Market Committee (FOMC) – the body responsible for U.S. monetary policy – comprises the seven Board members and the President of the Federal Reserve Bank of New York, plus four of the other eleven regional FED Presidents. Among the latter

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than sanctioning.

the right to vote rotates following a pre-determined sequence.<sup>30</sup> The twelve FED districts are not equal in size (measured either in terms of economic size and population).

In various aspects our design can be related to the FOMC: We have (i) regions of different sizes, (ii) a region with a permanent seat and (iii) the trade-off between common and individual interests. Regarding the latter, Meade and Sheets (2005) suggest that at least some FOMC members face a similar trade-off between regional and ‘common’ interests. Given these similarities, our results indicate that decisions taken by the FOMC need not always maximise U.S. welfare. FOMC members might use their right to vote to address economic conditions in their constituency, rather than the U.S. economy as a whole. Relative to a situation where all FOMC members vote, U.S. monetary policy might thus be biased. In addition, decisions might also be systematically biased in favour of the New York FED, as it has a permanent seat. That said, regional representation has a number of advantages, e.g. ensuring broad regional representation, gathering and sharing of regional information by regional FED Presidents etc., which were not captured in our experimental design. These are clearly issues for future research.

## Appendix: Theoretical predictions

### Overview

In determining how participants behave we can distinguish two alternative approaches: first, own interests dominate group interests. This can come in the form of ‘naive’ or ‘strategic’ voting: naive voting implies that participants simply vote for their first-best option, without considering possible strategic interactions. ‘Strategic’ voting is possible within each round, as every participant has perfect information about all committee members’ preferences’. Hence, each player can use backward induction to determine the subgame perfect equilibrium. Alternatively, it could be the case that group interests are more important than individual interests. In that case individuals could strive to maximise the total payoff for the group as a whole (i.e. the sum of individual and common payoffs), or simply aim at the highest common payoff. Table 5 and 6 contain theoretical predictions for the following behavioural modes:

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<sup>30</sup>The 1942 amendment to the Federal Reserve Act prescribes a rotation scheme of four seats on the FOMC among eleven Federal Reserve districts. This annual rotation began on March 1, 1943; since 1990, the rotation has taken place each year on January 1. One voting seat is rotated in a fixed fashion among members of each of the following FED districts: Cleveland and Chicago; Atlanta, Dallas, and St. Louis; Boston, Philadelphia, and Richmond; Kansas City, Minneapolis, and San Francisco (see Meade and Sheets, 2005). Johnson (1995) provides a good summary of the founding of the Federal Reserve.

- *Naive voting*: Players make sincere proposals and veto (absence of any strategic behaviour);
- *Strategic voting*: Players behaving strategically both in proposing options and vetoing them;
- *Median voter decisive*: The preferred option of the median voter is chosen;
- *Highest common payoff*: Maximisation of the common payoff;
- *Highest total payoff*: Maximisation of the total group payoff.

## Strategic voting

To solve for strategic voting we exploit the fact that all rounds are independent. Let the set of options be  $I = \{1, 2, 3, 4\}$  and let  $C$  denote the set of countries with the right to vote,<sup>31</sup> i.e.  $C = \{c \mid c \text{ in the committee}\}$ . Without any loss of generality let country 1, 2 and 3 be respectively the first, the second and the third country to propose an option. We derive subgame perfect equilibria using backward induction.

Figure 7 shows the game tree (at some given round). Suppose that at node  $i$ ,  $i \in \{1, 2, 3\}$  country  $i$  makes a proposal  $p_i \in I \setminus \{p_j, j = 1..i - 1\}$ , that is country  $i$  makes a proposal from the set of feasible proposals (the set  $I$  without the proposals that have been vetoed when the game reaches node  $i$ ). Next move will be at node  $i.o$ : voting country  $c$ , which is not the country that made a proposal at node  $i$  and which is in the committee, i.e.  $c \in C \setminus \{i\}$ , makes a decision on accepting or not proposal  $p_i$ . If proposal  $p_i$  at node  $i.o$  is accepted by all voting countries, then the game ends. Proposal  $p_i$  is implemented, each country (in or out of the committee) receives his payoff determined by the state of nature at  $p_i$ . Let  $u(p_i) = (u_j(p_i))_{j=1..5}$  denote the vector of utilities<sup>32</sup> that each country gets when option  $p_i$  is implemented. If proposal  $p_i$  at node  $i.o$  is rejected by at least one country  $c, c \in C \setminus \{i\}$  the game continues to the next node. At node 4, the game rule ‘an option can be proposed only once’ implies that there is only one option which is not yet proposed. That option becomes the proposal at that node, and all countries in the committee have the right to vote. If the left option receives at least one veto then the state  $d$  of ‘no agreement’ is reached. This is a state in which all countries receive the same money payoff, i.e.  $\pi_j(d) = D$  for all  $j = 1..5$ .

<sup>31</sup>Note that this set differs across rounds for equal and unequal rotation treatments.

<sup>32</sup>For example, country  $j$  utility may equal his monetary payoff, i.e.  $u_c(p_i) = \pi_c(p_i)$ .

Round	No rotation					Equal rotation					Unequal rotation				
	NV <sup>a</sup>	SV <sup>b</sup>	MV <sup>c</sup>	CP <sup>d</sup>	TP <sup>e</sup>	NV <sup>a</sup>	SV <sup>b</sup>	MV <sup>c</sup>	CP <sup>d</sup>	TP <sup>e</sup>	NV <sup>a</sup>	SV <sup>b</sup>	MV <sup>c</sup>	CP <sup>d</sup>	TP <sup>e</sup>
1	3	2	2	2	2	3	2	2	2	2	2	2	2	2	2
2	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	3	2	2	2	2	3	2	2	2	2	3	2	2	2	2
5	2	3	3	3,4	3,4	2	3	3	3,4	3,4	2	3	3	4	4,3
6	2	4	3	4	3	2	3	3	4	3	2	3	3	4	3
7	3	1	2	1,3	2	3	1	1	1,3	2	3	2	2	1	2
8	1	3	4	4	4	3	4	4	4	4	3	2	2	2	2
9	3	3	2	2	2	3	2	2	2	2	3	4	4	4	4
10	3	2	2	4	2	3	2	2	4	2	3	2	2	4	2
11	1	3	3	3	3	2	3	3	3	3	4	3	3	3	3
12	4	3	3	3	3	4	3	3	3	3	3	2	2	3	3
13	3	2	2	4	4	3	2	2	4	4	3	2	2	4	4
14	3	1	1	1	1	3	1	1	1	1	3	1	1	1	1
15	2	2	1	1	1	2	1	1	1	1	1	1	1	1	1
16	4	3	3	3	3	2	2	2	3	3	2	4	4	4	4
17	3	3	2	2	2	3	4	4	2	2	1	2	2	2	2
18	3	2	3	3,4	3,4	3	1	1	3,4	3,4	2	3	3	4	4,3
19	2	1	2	2	2	2	1	1	2	2	2	2	2	3	3
20	1	4	3	3,4	3,4	3	4	4	3,4	3,4	2	3	3	2	2
21	3	2	2	1	2	1	1	1	1	2	3	4	4	4	4
22	3	4	4	4	4	3	4	4	4	4	1	1	1	1	2
23	2	4	3	4	4	2	4	4	4	4	3	4	4	4	4,3
24	3	2	2	2	2	3	2	2	2	2	2	1	1	2	2
25	2	3	2	3	2	2	3	3	3	2	1	3	3	4	4

<sup>a</sup>Naive voting

<sup>b</sup>Strategic voting

<sup>c</sup>Median voter decisive

<sup>d</sup>Highest common payoff: the option to maximise the common payoff

<sup>e</sup>Highest total payoff: the option to maximise the total group payoff

Table 5: Theoretical predictions (rounds 1-25)

Round	No rotation					Equal rotation					Unequal rotation				
	NV <sup>a</sup>	SV <sup>b</sup>	MV <sup>c</sup>	CP <sup>d</sup>	TP <sup>e</sup>	NV <sup>a</sup>	SV <sup>b</sup>	MV <sup>c</sup>	CP <sup>d</sup>	TP <sup>e</sup>	NV <sup>a</sup>	SV <sup>b</sup>	MV <sup>c</sup>	CP <sup>d</sup>	TP <sup>e</sup>
26	3	4	4	4	4	3	4	4	4	4	3	2	2	2	2
27	3	2	2	1	2	3	2	2	1	2	3	2	2	1	2
28	3	3	4	4	4	3	3	3	4	4	3	3	3	4	4
29	1	3	2	2	2	3	2	2	2	2	3	2	2	2	2
30	1	3	3	3	3	3	3	3	3	3	3	4	4	4	4
31	2	3	3	3	3	2	3	3	3	3	3	2	2	2	2
32	1	3	3	4	4	3	4	4	4	4	3	3	3	3	3
33	1	2	2	2	2	1	2	2	2	2	2	3	3	3	3
34	1	2	2	2	2	3	2	2	2	2	4	3	3	4	3
35	2	3	3	4	3	2	3	3	4	3	1	2	2	2	2
36	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
37	4	2	2	1	1	3	2	2	1	1	1	4	4	1	1
38	2	3	2	1	1	1	4	4	1	1	3	2	2	1	1
39	3	2	3	2	2	3	2	2	2	2	4	4	4	4	4
40	1	2	2	2	2	3	2	2	2	2	3	3	3	3	3
41	4	4	4	4	4	4	4	4	4	4	3	2	2	2	2
42	2	3	3	3	3	2	3	3	3	3	2	3	3	3	2
43	4	2	2	2	2	1	1	1	2	2	1	2	2	2	2
44	1	3	2	2	2	2	3	3	2	2	3	2	2	2	2
45	3	2	1	1	1	3	2	2	1	1	3	1	1	1	1
46	4	1	1	1	1	1	1	1	1	1	3	1	1	1	1
47	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
48	1	3	3	3	3	3	3	3	3	3	1	3	3	3	3
49	3	2	3	4	4	3	1	1	4	4	3	3	3	3	3
50	1	2	1	1	1	1	2	2	1	1	1	2	1	1	1

<sup>a</sup>Naive voting

<sup>b</sup>Strategic voting

<sup>c</sup>Median voter decisive

<sup>d</sup>Highest common payoff: the option to maximise the common payoff

<sup>e</sup>Highest total payoff: the option to maximise the total group payoff

Table 6: Theoretical predictions (rounds 25-50)

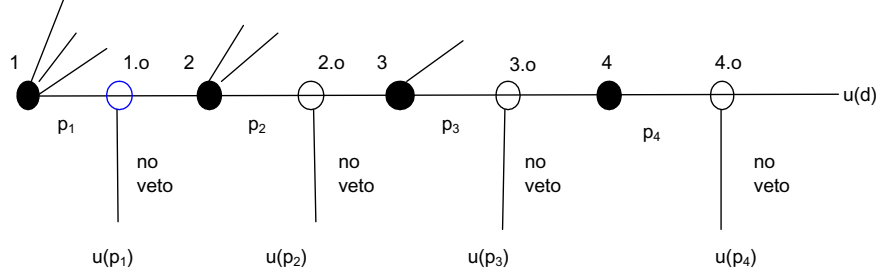


Figure 7: Game tree

To solve using backward induction suppose that the game is at some node 4.<sup>33</sup> Let the left option be  $p_4$ ,  $l \in I \setminus \{p_i : i = 1, 2, 3\}$ , where  $p_i$  is the option proposed by country  $i$ . At node 4.o, the veto strategy of country  $c \in C$  is: accept option  $p_4$  iff utility at  $p_4$  is not smaller than at  $d$ . Formally, this is written as

$$\forall p_4 \in I \setminus \{p_i\}, \forall c \in C$$

$$\begin{aligned} v_c^A(p_4) &= \text{accept, if } u_c(p_4) \geq u_c(d), \\ &= \text{veto, otherwise} \end{aligned} \quad (1)$$

where  $d$  is the state where no agreement is reached.<sup>34</sup> This implies that the outcome at node 4, the game outcome  $f_4(p_i | i = 1, 2, 3)$  is

$$\begin{aligned} f_4(p_i) &= p_4, \text{ if } \forall c \in C, u_c(p_4) \geq u_c(d), \\ &= d, \text{ if } \exists c \in C, u_c(p_4) < u_c(d). \end{aligned}$$

Denote  $f_4^* = f_4(p_i | i = 1, 2, 3)$ . Now consider node 3. Proposals that are feasible at this node belong to  $I \setminus \{p_1, p_2\}$ . Suppose that country 3 at that node 3 proposes option  $p_3$ . At node 3.o, country  $c \in C \setminus \{3\}$  veto strategy is: accept option  $p_3$  iff utility at  $f_4^*$ , (which is the final outcome if the game reaches node 4) is not larger than at  $p_3$ . Formally,

<sup>33</sup>Note that there are 24 possible nodes 4. These nodes differ from each other by the path of proposals made and rejected up to node 4. Remember, however, that we have 6 nodes of type 4 with the same proposal  $i$  left on the floor since the size of the options set is 4. Hence, there is more than one path ending up at winning option  $i$ . We will be looking for the shortest paths assuming all players prefer to agree on an option sooner rather than later.

<sup>34</sup>Including the equality in the first row assumes that all countries prefer to reach an agreement earlier than later. Thus, countries do not like to veto an option in case of indifference which seems plausible.

$$\forall p_3 \in I \setminus \{p_1, p_2\}, \forall c \in C \setminus \{3\}$$

$$\begin{aligned} v_c^3(p_3) &= \textit{accept}, \text{ if } u_c(p_3) \geq u_c(f_4^*) \\ &= \textit{veto}, \text{ otherwise} \end{aligned} \quad (2)$$

Hence, the outcome at node 3.o,  $f_3(p_3 \mid p_1, p_2)$  is given by

$$\begin{aligned} f_3(p_3 \mid p_1, p_2) &= p_3, \text{ if } \forall c \in C \setminus \{3\}, u_c(p_3) \geq u_c(f_4^*) \\ &= f_4^*, \text{ if } \exists c \in C \setminus \{3\}, u_c(p_3) < u_c(f_4^*) \end{aligned}$$

The common knowledge information setting of the game and rationality imply that at node 3 country 3 proposes an option  $p_3(p_1, p_2)$  that maximizes his own utility. Formally,

$$p_3^* \equiv p_3(p_1, p_2) = \arg \max\{u_3(f_3(p_3 \mid p_1, p_2)) : p_3 \in I \setminus \{p_1, p_2\}\} \quad (3)$$

Let  $f_3^* \equiv f_3(p_3^* \mid p_1, p_2)$  denote the outcome of the reduced game at node 3 (see figure 2). Given that, the veto strategy at node 2.o is as follows:

$$\forall p_2 \in I \setminus \{p_1\}, \forall c \in C \setminus \{2\}$$

$$\begin{aligned} v_c^2(p_2) &= \textit{accept}, \text{ if } u_c(p_2) \geq u_c(f_3^*) \\ &= \textit{veto}, \text{ otherwise} \end{aligned} \quad (4)$$

Hence, the outcome at node 2.o,  $f_2(p_2 \mid p_1)$  is

$$\begin{aligned} f_2(p_2 \mid p_1) &= p_2, \text{ if } \forall c \in C \setminus \{2\}, u_c(p_2) \geq u_c(f_3^*) \\ &= f_3^*, \text{ if } \exists c \in C \setminus \{2\}, u_c(p_2) < u_c(f_3^*) \end{aligned}$$

Similarly as for country 3, we have that country 2 at node 2 proposes

$$p_2^* \equiv p_2(p_1) = \arg \max\{u_2(f_2(p_2 \mid p_1)) : p_2 \in I \setminus \{p_1\}\} \quad (5)$$

Let  $f_2^* \equiv f_2(p_2^* \mid p_1)$  denote the outcome of the reduced game at node 2. Writing the same derivations for node 1.o and node 1 one has:

- the veto strategy at node 1.o is given by  $\forall p_1 \in I, \forall c \in C \setminus \{1\}$

$$\begin{aligned} v_c^1(p_1) &= \textit{accept}, \text{ if } u_c(p_1) \geq u_c(f_2^*), \\ &= \textit{veto}, \text{ otherwise;} \end{aligned} \quad (6)$$

- the outcome at node 1.o,  $f_1(p_1)$  is

$$\begin{aligned} f_1(p_1) &= p_1, \text{ if } \forall c \in C \setminus \{1\}, u_c(p_1) \geq u_c(f_2^*), \\ &= f_2^*, \text{ if } \exists c \in C \setminus \{1\}, u_c(p_1) < u_c(f_2^*); \end{aligned}$$

- the proposal of country 1 at node 1 is determined by

$$p_1^* \equiv \arg \max\{u_1(f_1(p_1)) : p_1 \in I\} \quad (7)$$

Summarising, in a subgame perfect equilibrium:

1. The winning proposal is  $f_1(p_1^*)$ ;
2. Country 1 proposes option  $p_1^*$ ; if rejected then country 2 proposes  $p_2^* = p_2(p_1^*)$ ; if rejected then country 3 proposes  $p_3^* = p_3(p_1^*, p_2^*)$ ;
3. Country  $i$ 's proposal strategy at each node  $i$  is given by (3), (5) and (7);
4. Country  $c$ 's veto strategy at each node  $i.o$  is given by (1), (2), (4) and (6).

## Example

As an example consider round 6 in the experiment. The matrix of total individual payoffs at this round is

<i>Option</i>	1	2	3	4
<i>Country 1</i>	201.25	407.5	580	432.5
<i>Country 2</i>	126.25	307.5	430	582.5
<i>Country 3</i>	201.25	407.5	580	432.5
<i>Country 4</i>	126.25	307.5	430	582.5
<i>Country 5</i>	301.25	557.5	430	332.5

and the payoff vector in case of 'no agreement reached' is  $[10, 10, 10, 10, 10]$ . In that round, country 4 was the first to make a proposal, country 1 was the second one and country 5 was the third proposer.

Assume that country's preferences over options are represented by the following utility function:

$$u_j(i) = \pi_c(i), \forall c \in C, \forall i \in I$$

where  $\pi_c(i)$  is the individual monetary payoff that country  $j$  receives if option  $i$  is implemented. Applying backward induction and shortest path criteria gives:

**Rotation** ‘Country 4 proposes option 3. Country 1 and 5 accept.’

Option 3 is the first best option for country 1. For country 5 the first best option is option 2, whereas option 3 is the second best. But country 5 can do no better than option 3 since if he vetos option 3 then for both other two countries, 4 and 1, option 4 becomes the most attractive one. Those two countries will ally and at the next turn (node 2) country 1 proposes option 2 and country 4 rejects it. After that, the best left option for all three countries is option 4. But country 5 prefers option 3 to option 4 and therefore he will not veto that option at node 2. Similarly, one can verify that country 4 can not do any better than option 3, given the preferences of two other countries, and assuming that he likes the option to be chosen sooner than later he proposes that option at his turn.

**No rotation** ‘Country 4 proposes option 3, which is rejected by country 2; country 1 proposes option 2 which is rejected by for e.g., country 4; country 5 proposes option 4 which is accepted by all countries.’

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