

Sauermann, Jan

**Article — Published Version**

## On the instability of majority decision-making: testing the implications of the 'chaos theorems' in a laboratory experiment

Theory and Decision

**Provided in Cooperation with:**

Springer Nature

*Suggested Citation:* Sauermann, Jan (2020) : On the instability of majority decision-making: testing the implications of the 'chaos theorems' in a laboratory experiment, Theory and Decision, ISSN 1573-7187, Springer US, New York, NY, Vol. 88, Iss. 4, pp. 505-526, <https://doi.org/10.1007/s11238-019-09741-4>

This Version is available at:

<https://hdl.handle.net/10419/289035>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by/4.0/>



# On the instability of majority decision-making: testing the implications of the ‘chaos theorems’ in a laboratory experiment

Jan Sauermann<sup>1</sup> 

Published online: 13 January 2020  
© The Author(s) 2020

## Abstract

In light of the so-called ‘chaos theorems’ from social choice theory, William Riker (W. H. Freeman and Company, San Francisco, 1982) argues that the indeterminacy of majority rule leads to voting cycles making democratic decisions arbitrary and meaningless. Moreover, when the core is empty, majority instability correlates with the level of conflict among actors. This study uses laboratory committee decision-making experiments to provide an empirical test of both aspects of Riker’s argument. Committees make repeated majority decisions over 20 periods picking points from a two-dimensional policy space. The experiment manipulates committee members’ preferences and thus varies the existence of a core and the level of conflict between group members. The experimental results contradict Riker’s interpretation of the chaos theorems’ implications. Thus, the core exhibits less attraction than generally assumed. Moreover, an empty core is not associated with increased majority rule instability. Instead, conflicting preferences lead to more instability irrespective of the existence of an equilibrium.

**Keywords** Committee decision-making · Laboratory experiment · Majority rule · Social choice

---

**Electronic supplementary material** The online version of this article (<https://doi.org/10.1007/s11238-019-09741-4>) contains supplementary material, which is available to authorized users.

---

✉ Jan Sauermann  
[jan.sauermann@uni-koeln.de](mailto:jan.sauermann@uni-koeln.de)

<sup>1</sup> Cologne Center for Comparative Politics, University of Cologne, P.O. Box 411020, 50870 Cologne, Germany

## 1 Introduction

For a long time, questions concerning the predictability of majority rule have inspired discussions about the viability and meaning of democratic decision-making. Already Condorcet (1785/1995) noted that transitive individual preferences can lead to intransitive social preference orders. In the twentieth century, several well-known social choice theorems, most notably Arrow's (1963) Impossibility Theorem, formalized and extended Condorcet's theoretical insight.<sup>1</sup> For instance, Black (1948) showed that the outcome of majority decision-making equals the median voter's preference if all choice alternatives fall into a one-dimensional policy space and voters' preferences are single-peaked.<sup>2</sup>

The most frequently used equilibrium concept for higher-dimensional policy spaces is that of the majority core. An alternative  $x$  is in the majority core if there is no other alternative  $y$  in the policy space such that a majority of voters prefer  $y$  to  $x$ . However, preferences have to fulfill strict symmetry conditions so that a core exists (Davis et al. 1972; Plott 1967). Under simple majority rule, an alternative in the core is a median in all directions. Every line drawn through it divides the ideal points of all voters so that at least half are on either side of the line (Hinich and Munger 1997, 65). Hence, existing equilibria are highly fragile and vulnerable to minor changes of voters' preferences. Consequently, the core is empty for most decisions under majority rule.

The theoretical implications of an empty core are far-reaching. The so-called 'chaos theorems' by McKelvey (1976, 1979) and Schofield (1978) proof that when transitivity of collective preferences breaks down, it breaks down completely. A path consisting of a finite number of majority decisions connects any two points in the policy space. Hence, any point in the policy space can be reached given the appropriate sequence of voting. The McKelvey–Schofield theorems have several implications. For instance, McKelvey (1976) highlights the resulting importance of agenda-setting power, i.e. the right to make proposals in the voting decisions. If an individual voter controls the agenda, she can influence decision-making to her own benefit and propose a voting sequence that eventually leads to the selection of her own ideal point (see Cox and Shepsle 2007).

In this paper, I focus on the theorems' empirical implications for the instability of majority decision-making. I define majority rule instability as the extent to which groups with fixed voters' preferences choose different outcomes over time. The theorems demonstrate the theoretical indeterminacy of the outcomes of majority decision-making. However, as Austin-Smith and Banks (1999, 184) point out, indeterminacy does not necessarily imply instability:

<sup>1</sup> Arrow (1963) generalized Condorcet's voting paradox showing that all non-dictatorial decision rules that satisfy certain minimal fairness criteria might produce intransitive collective preference orders. Hence, there is a tradeoff inherent in all democratic voting rules. Either a collective decision mechanism guarantees a fair aggregation of preferences or an unambiguous social choice.

<sup>2</sup> Single-peaked preferences imply that each voter has an ideal point in the policy space. Actors prefer alternatives that are closer to this point.

[...] it is important to emphasize that these instability and chaos theorems are results of the consistency of the various means of aggregating individual preferences. As such they are not results on individual behavior or the aggregation of such behavior, they are facts about the formal properties of preference aggregation rules on given sets of profiles. In particular, the results do not predict that political behavior is chaotic or that “anything can happen”.

Consequently, it remains an open question, whether intransitive collective preferences lead to unstable majority decisions or not.

Riker (1982) offers the most far-reaching interpretation of the implications of the theoretical indeterminacy of majority decision-making. He is a strong proponent of a position of democratic irrationalism and argues that the indeterminacy of majority rule leads to voting cycles which make democratic decisions arbitrary and meaningless. When the core is empty “wide swings in political choices are possible and expected” (1982, 188). In addition, Riker adds a second aspect to his argument claiming that the instability of majority decision-making is also driven by the dissatisfaction of the losers under the current status quo policy. If voters’ preferences differ sharply and conflict among group members is high, the dissatisfaction of outvoted actors is also high. Thus, the higher the dissatisfaction with the status quo, the stronger becomes current losers’ motives to upset the current outcome (cf. Riker 1982, 208). Therefore, when the core is empty, majority instability correlates with the level of conflict among actors.

In this study, I test both aspects of Riker’s claim of the irrationality of democratic decisions in a comprehensive experimental framework. Only few existing studies examine the effects of the existence of a core in majority decisions and mostly find that an empty core does not lead to “chaotic” collective decisions. The influence of conflict on the stability of democratic decisions, however, has never been explored systematically. The experimental results thus add an important new insight to the collective decision-making literature by showing that the behavioral effects of the level of conflict in a decision dominate the effect of the existence of a core.

The remainder of the paper is structured as follows. The following section reviews the existing empirical evidence on the instability of majority rule. Section 3 explains the experimental design, Sect. 4 presents the results, and Sect. 5 concludes.

## 2 Empirical evidence on the instability of majority rule

There is disagreement in the literature about the empirical relevance of majority rule instability. Riker (1982) argues that cyclic majorities are ubiquitous and thus a highly important phenomenon. He supports his claim citing several historical anecdotes like the events cumulating in the American civil war (see also Riker 1986). Mackie (2003), however, challenges Riker’s arguments by showing that all empirical evidence for the existence of voting cycles presented by Riker rests on false assumptions about actors’ preferences.

Browne and Hamm (1996) analyze the passage of the 1951 Electoral Reform Act in Fourth Republic France and find evidence for the existence of a voting cycle during the

first stage of the legislative process in the French National Assembly. Stratmann (1996) also empirically tests for the existence of majority rule cycles using data from decisions made in US Congress. He argues that majority rule instability implies that beneficiaries and losers of political decisions vary over time. Therefore, total benefits among voters should display less variation than the distribution of benefits resulting from single decisions. Stratmann analyzes federal programs from 1985 to 1990 that flow into congressional districts. Contrary to the cycling hypothesis, he finds that the variance of grants in each year is smaller than the variance of the sum of grants over the six years under investigation. Hence, the results indicate that Congress decisions produce stable winners and losers over time rather than cyclic majorities.

The unobservability of individual preferences poses a major obstacle for a thorough assessment of the prevalence of majority instability based on field data. Usually, the inference of preferences is fraught with uncertainty. Experimental methods, however, provide a solution to this problem offering researchers tight control over the data generating process (e.g. Morton and Williams 2010). In particular, monetary incentives can be used to induce individual preferences (Smith 1976). Moreover, the McKelvey–Schofield theorems assume a frictionless and institution-free environment for collective decision-making. Of course, real-world decisions usually violate this assumption because they are characterized by transaction costs and information costs, and moreover, exhibit a distinctive institutional setting governing the decision-making process. Laboratory experiments, however, offer the possibility to create an environment imposing only minimal friction and institutional structure in collective decisions.

Committee decision-making experiments provide the best setting for testing the empirical implications of the McKelvey–Schofield theorems. In their seminal study, Fiorina and Plott (1978) study five-member committees which have to pick points from a two-dimensional policy space by majority rule. Group members are represented by their ideal points in the policy space. Fiorina and Plott induce Euclidean preferences using monetary incentives. Hence, subjects earn more if the committee chooses a point close to their respective ideal points.

Fiorina and Plott conduct their experiment as a one-shot game. Hence, committees make a single binding decision. Decision-making starts from an unattractive status quo at the margin of the policy space. Then, upon recognition by the neutral experimenter, a group member can propose an amendment to the current status quo. If a majority of group members supports the proposal in a subsequent vote, it becomes the new status quo. Otherwise the old status quo persists. Instead of proposing an amendment to the status quo, committee members can also propose to adjourn decision-making. The decision ends, if a majority of group members supports a proposal to adjourn. The current status quo then becomes the outcome of the committee decision.

Among other things, Fiorina and Plott vary the existence of a core. In Series 1 of their experiments, the preference configuration creates a non-empty core (Player 1's ideal point). Series 3 uses almost the same preference configuration.<sup>3</sup> The only

<sup>3</sup> While Series 1 and Series 3 use Euclidean preferences, Series 2 uses non-separable elliptical preferences.

difference between the two series is a small shift of Player 1's ideal point, which creates a preference configuration with an empty core. Fiorina and Plott only find minor behavioral differences between the two treatments. Thus, results cluster closely around the core in Series 1. Moreover, the non-existence of a core in Series 3 is not associated with 'chaotic' committee decisions. The standard distance deviation of points chosen by committees in Series 3 is only slightly higher than the variation of outcomes in Series 1. In absence of an equilibrium, results also cluster in the central area of the policy space.

In a more recent study, Sauermann (2016) replicates Fiorina's and Plott's (1978) main finding. Sauermann (2016) employs the same configuration of ideal points as Series 1 and Series 3 of Fiorina's and Plott's (1978) study, but contrary to Fiorina and Plott where committees make single binding decisions, groups make repeated majority decisions over time. The results confirm that an empty core has no noticeable behavioral effects in comparison to a situation with equilibrium. However, the attraction of the core is weaker than theoretically predicted. In particular, Sauermann finds that results diverge from the core in the course of the experiment.

Several other experimental studies also corroborate the finding that an empty core does not lead to chaotic outcomes in majority decision-making (e.g. Endersby 1993; Laing and Olmsted 1978; McKelvey and Ordeshook 1984; McKelvey et al. 1978; Wilson 1986, 2008). The dominant preference-based explanation for the apparent stability of majority rule is the uncovered set (Miller 1980).<sup>4</sup> The set's underlying logic assumes that voters act strategically considering the ultimate consequences of their actions instead of choosing myopically.<sup>5</sup> The uncovered set has received wide empirical support in laboratory experiments. For instance, Bianco et al. (2006) re-examine the results of most existing studies of committee decision-making and find that more than 90% of all chosen points lie in the uncovered set.

In this study, I argue that there are still several open questions concerning the empirical implications of the McKelvey–Schofield theorems. From the theoretical point of view, the existence of a core is of central importance for the predictability of majority decision-making. If an equilibrium exists, theory makes a very precise point prediction while an empty core allows for more variation of outcomes. I argue that this aspect deserves more attention. For instance, the studies of Fiorina and Plott (1978) and Sauermann (2016) are the only experiments that vary the existence of a core while keeping all other parameters constant. Moreover, apart from Sauermann (2016) the entire existing experimental evidence is based on one-shot games where committees make a single binding decision. However, majority rule instability can

<sup>4</sup> The McKelvey–Schofield theorems have also sparked a large literature on institutional constraints on majority rule instability. Shepsle (1979) argues that institutions such as agenda control or a committee system induce structure on otherwise indeterminate decisions. For instance, institutions like the germaneness rule restrict decisions to a single dimension and thus prevent majority rule instability (Shepsle and Weingast 1981). However, Riker (1980) objects that in the long term, institutions are endogenous to the political process. Consequently, institutional constraints cannot provide an ultimate explanation for the apparent stability of majority rule.

<sup>5</sup> An alternative  $x$  is covered by alternative  $y$ , if  $y$  beats  $x$  in a pairwise vote, and any alternative that beats  $y$  also beats  $x$ . The uncovered set comprises of all alternatives that are not covered by another alternative.

only be unequivocally identified when a group with fixed preferences chooses different outcomes over time. Therefore, I argue that dynamic games where subjects make repeated decisions over time provide a better setting for testing the stability of majority decision-making. Hence, the first goal of this study is to replicate the experimental design of Sauermann (2016) and provide additional empirical evidence of the effects of the existence of a core in repeated committee decisions under various new configurations of voters' ideal points.

An additional open question concerns the influence of conflict among group members. As I discuss above, Riker (1982) argues that discontent of losers under the current status quo drives policy change. This reasoning implies that majority instability increases with the level of conflict among group members. To the best of my knowledge, this implication has never been tested empirically in a systematic way. Hence, the second goal of this study is to fill this gap. In the following, I will present an experimental design addressing the effects of the existence of a core and the level of conflict in repeated committee decisions under majority rule.

### 3 Experimental design

The experiment replicates the general design features of Sauermann (2016), which again builds on Fiorina and Plott (1978). I study five-person committees that have to pick points from a two-dimensional policy space consisting of  $200 \times 150$  units. The experiment uses a neutral framing. Hence, committee members are labeled A, B, C, D, and E, and the dimensions of the policy space are denoted "X" and "Y" without referring further meaning to the decision. In order to be able to investigate the development of group choices of time, committees make repeated decisions over 20 periods. In every period, subjects play for tokens. After the final period, all tokens earned during the experiment by a subject are summed up and transferred into money at a conversion rate of 1 Euro per 1000 tokens. Payouts induce Euclidean preferences. Hence, each committee member has an individual ideal point in the policy space. The number of earned tokens decreases if the distance between a committee member's ideal point and the outcome of the group decision in a period increases. Hence, subjects have material incentives to influence group decision-making in the direction of their own ideal points.

Groups decide by majority rule. Similar to the experiment of Fiorina and Plott (1978), decision-making in the first period starts from a point at the top-right margin of the policy space (190|140). This starting point is highly unattractive for all committee members and is selected to minimize possible biases for the later decision-making process. In order to limit the effect of agenda-setting power, the right to make proposals alternates randomly among group members during the experiment. At the beginning of a period, the computer randomly assigns agenda control to a committee member. The designated agenda setter then has two options. For one, she can maintain the current status quo. In that case, the status quo becomes the result of the current period and the period ends. Alternatively, the agenda setter can propose a new point. Then the committee decides by majority rule between the

proposal and the current status quo. Every committee member has one vote.<sup>6</sup> The alternative receiving the majority of votes is the outcome of the current period. Afterwards, a new period starts and the computer again assigns agenda control randomly to a committee member. The outcome of the former period serves as the status quo of the new period.

The experiment uses partner matching. Thus, the composition of committees remains stable throughout the 20 periods of the experiment. In order to avoid uncontrolled interactions among subjects, the experiment is programmed in z-Tree (Fischbacher 2007), and committees interact exclusively via a computer network. Hence, subjects do not know the identity of the other members of their committee. Furthermore, there is no direct communication among committee members.

As discussed above, the McKelvey–Schiefelthorn theorems assume a frictionless and institution-free environment which cannot be found in any real-world decision, including collective decisions in the laboratory. Laboratory experiments, however, offer opportunities to minimize friction and the influence of institutions. To minimize information costs, group members receive complete information about each other's payoffs. Hence, agenda setters know the distribution of tokens for all committee members under the current status quo. Moreover, before submitting a proposal, agenda setters can click on any point in the policy space and learn the respective distribution of points for the whole committee. When deciding between a proposal and the current status quo, committee members also receive information about the resulting payouts of both alternatives for all committee members.

### 3.1 Experimental treatments

The experiment consists of four treatments varying the existence of a core and the level of conflict among committee members in a  $2 \times 2$  design. All treatments use the same payout function for all committee members.<sup>7</sup> If the committee chooses a subject's ideal point, the respective subject earns 1000 tokens. With increasing distance to a subject's ideal point, payoffs decrease, yet never become negative. Locations of committee members' ideal points in the policy space are the only elements differing between treatments. As Fig. 1 shows, the configurations of ideal points in the Core—low-conflict treatment<sup>8</sup> and in the Core—high-conflict treatment<sup>9</sup> satisfy Plott's (1967) symmetry conditions. In both treatments,

<sup>6</sup> The vote of the agenda setter automatically counts in favor of her own proposal. Thus, the proposal wins if it attracts the votes of at least two other committee members.

<sup>7</sup> The exact parametrization of payout functions is:

$$\text{tokens} = 0.6 \times \left( 1000 \times e^{-\left(\frac{\text{distance}}{55}\right)} \right) + 0.4 \times \left( 1000 \times e^{-\left(\frac{\text{distance}^2}{8000}\right)} \right), \text{ with}$$

$$\text{distance} = \sqrt{(x - \text{opt\_}x_i)^2 + (y - \text{opt\_}y_i)^2},$$

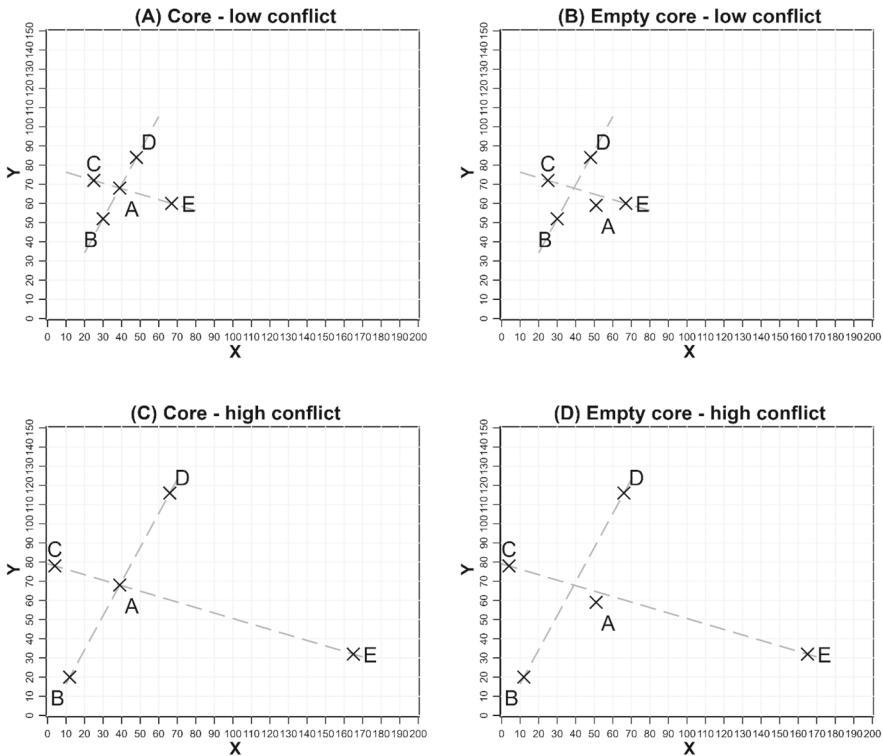
opt\_ $x_i$  =  $x$ -coordinate of Participant  $i$ 's ideal point, and

opt\_ $y_i$  =  $y$ -coordinate of Participant  $i$ 's ideal point.

<sup>8</sup> The coordinates of committee members' ideal points in the Core—low conflict treatment are: A: (39|68), B: (30|52), C: (25|72), D: (48|84), E: (67|60).

<sup>9</sup> The coordinates of committee members' ideal points in the Core—high conflict treatment are: A: (39|68), B: (12|20), C: (4|78), D: (66|116), E: (165|32).





**Fig. 1** Configurations of ideal points

committee member A's ideal point lies in the intersection of the lines going through B's and D's ideal points and C's and E's ideal points, respectively. The core thus equals A's ideal point.

The Empty core—low-conflict treatment<sup>10</sup> and the Empty core—high-conflict treatment<sup>11</sup> employ almost the same preference configuration as the two core treatments. The only difference is a small shift of committee member A's ideal point from point (39|68) to point (51|59), which abolishes the equilibrium. Hence, the core is empty in these two treatments.

The manipulation of conflict follows the idea that most political decisions involve distributional conflicts of who gets what, when, and how (Lasswell 1936). Therefore, the ideal point configurations in Fig. 1 induce different levels of distributional conflict between committee members. In the experiment, conflict corresponds with differences among individual payouts of voters. Hence, conflict about a certain outcome is high if payouts under the given alternative differ sharply. However, if payouts are rather similar, disagreement about a certain outcome among

<sup>10</sup> The coordinates of committee members' ideal points in the Empty core—low conflict treatment are: A: (51|59), B: (30|52), C: (25|72), D: (48|84), E: (67|60).

<sup>11</sup> The coordinates of committee members' ideal points in the Empty core—high conflict treatment are: A: (51|59), B: (12|20), C: (4|78), D: (66|116), E: (165|32).

group members will be low. The experiment manipulates the level of conflict by varying the distances between committee members' ideal points. Because of this manipulation, the range of payouts is substantially higher in the high-conflict treatments compared to the low-conflict treatments.<sup>12</sup> Accordingly, being outvoted is worse in the high-conflict treatments. At the same time, the experimental manipulation tries to preserve the general symmetry of the preference configurations. In comparison to the low-conflict treatments, the two high-conflict treatments shift B's and D's ideal points to the margin of the policy space along the line connecting both points. The manipulation of C's and E's ideal points works analogously. Hence, the angle between the line connecting the ideal points of B and D and the line through C and E is identical in all four treatments.

### 3.2 Predictions

Based on the induced payoff configurations and the imposed decision-making rules, the Romer–Rosenthal (1978) setter model can be used to deduce predictions about committee decisions and the expected behavior of individual committee members. In each period of the experiment, the designated agenda setter can make a take-it-or-leave-it offer to the other committee members. The proposal is accepted if the majority of group members supports it. The model assumes rational and strategically acting players. Therefore, actual agenda-setting power is bounded by the size of the winset of the status quo, i.e. alternatives that a majority of group members prefers over the current status quo. Hence, the model predicts that an agenda setter will propose the alternative from the winset that minimizes the distance to her own ideal point in order to maximize payoffs in the current period.<sup>13</sup>

When the core is non-empty, Plott's (1967) symmetry conditions imply that the winset of a status quo differing from the core only contains alternatives located closer to the core than the current status quo. In repeated committee decisions, the model thus predicts convergence of outcomes on the core. Hence, the average distance of alternatives to the core should decrease over time. Moreover, when Player A receives agenda control, she will propose her own ideal point—i.e. the core—and a majority of group members will confirm the proposal. Furthermore, committees are expected to choose the core in all remaining periods of the experiment.

In the two empty-core treatments, the winset of the status quo is never empty. Hence, the model does not predict that chosen alternatives converge on a certain point from the policy space. Moreover, winsets are generally larger in the Empty core—high-conflict treatment than in the Empty core—low-conflict treatment for any given status quo. Hence, the model predicts more volatile decisions in the Empty core—high conflict treatment.

<sup>12</sup> Supplementary material A contains plots of the range of payouts in the different treatments.

<sup>13</sup> When group members receive agenda-setting power in two or more consecutive periods, the model predicts that agenda setters will improve their position as long as the winset is non-empty. If the winset is empty, the model predicts the preservation of the current status quo. Either agenda setters do not make a proposal and maintain the current status quo or agenda setters propose any alternative from the policy space and a majority of group members vote to maintain the current status quo.

In sum, in conformance with Riker's (1982) argument the model predicts quick conversion of chosen alternatives on the core irrespective of the level of conflict if the core exists. If the core is empty, however, majority instability is expected to correlate with the level of conflict among actors.

## 4 Experimental results

The experiment was conducted in December 2012 and January 2013 in the Cologne Laboratory for Economic Research. Participants were recruited from a subject-pool comprising more than 3000 registered subjects using ORSEE (Greiner 2015). In each treatment, 60 participants formed 12 committees. Thus, 240 subjects participated in the experiment—134 female and 104 male participants.<sup>14</sup> Most of the participants (97.5%) were students of the University of Cologne, among them 101 (42.1%) students of economics, management and related fields.

At the beginning of the experiment, subjects were randomly seated in cubicles preventing uncontrolled interactions among participants. Then participants read the instructions explaining the rules of the game in detail.<sup>15</sup> The experimenters answered remaining questions privately. After reading the instructions, subjects filled in a brief questionnaire testing the understanding of the rules of the decision-making process. After all participants had completed the questionnaire successfully, decision-making started. The experiment took about 95 min, and subjects earned on average € 16.29 including a show-up fee of € 2.50, which was paid as a lump-sum payment for showing up at the laboratory on time.

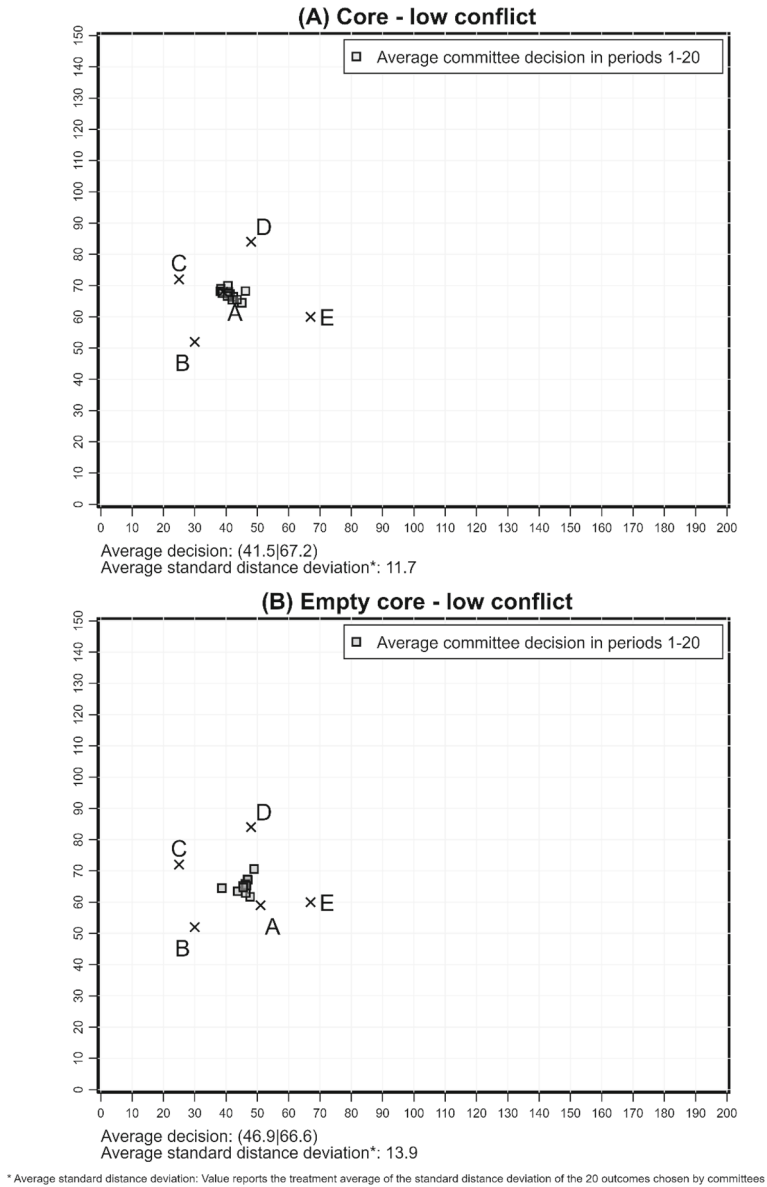
### 4.1 Majority rule instability

Figure 2 shows the locations of average outcomes in the two low-conflict treatments. Committees in the Core—low conflict treatment choose on average point (41.5|67.2). Likewise, average outcomes in the Empty core—low conflict treatment (46.9|66.6) also cluster in the central area of committee members' Pareto set. Hence, at first glance an empty core does not lead to large behavioral differences.

Instability of majority decision-making is the central dependent variable of this study. Decision-making is unstable, if committees with fixed voters' preferences choose different outcomes over time. There are different ways of operationalizing and measuring instability. The standard distance deviation, for instance, measures the dispersion of chosen outcomes around their geometric mean. Here, I compute the standard distance deviation of the twenty outcomes chosen by a committee during the experiment as a measure of dispersion of group decisions over time. The average dispersion of outcomes is slightly lower in the Core—low conflict treatment (average standard distance deviation: 11.7) compared to the Empty core—low conflict treatment (13.9). A two-tailed Fisher–Pitman permutation test for two

<sup>14</sup> Two subjects did not answer the question about their gender.

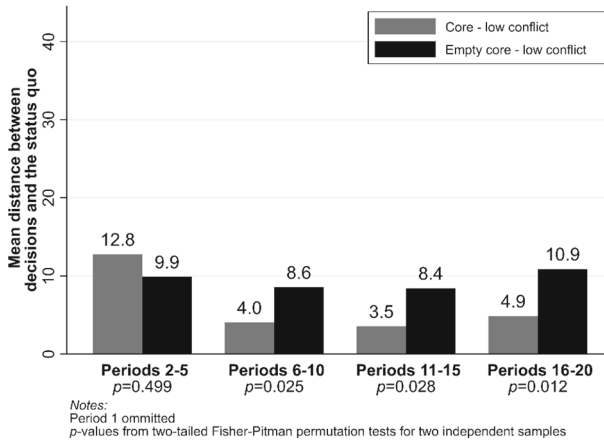
<sup>15</sup> Supplementary material B contains English translations of the instructions.



**Fig. 2** Average committee decisions in the low-conflict treatments

independent samples, however, indicates no significant difference between the two treatments ( $p = 0.348$ ).

The Euclidean distance between the status quo and the outcome chosen by a committee in a period provides an alternative measure for the instability of collective decisions over time. Instability increases when the distance between the outcome of the current period and the outcome of the previous period becomes



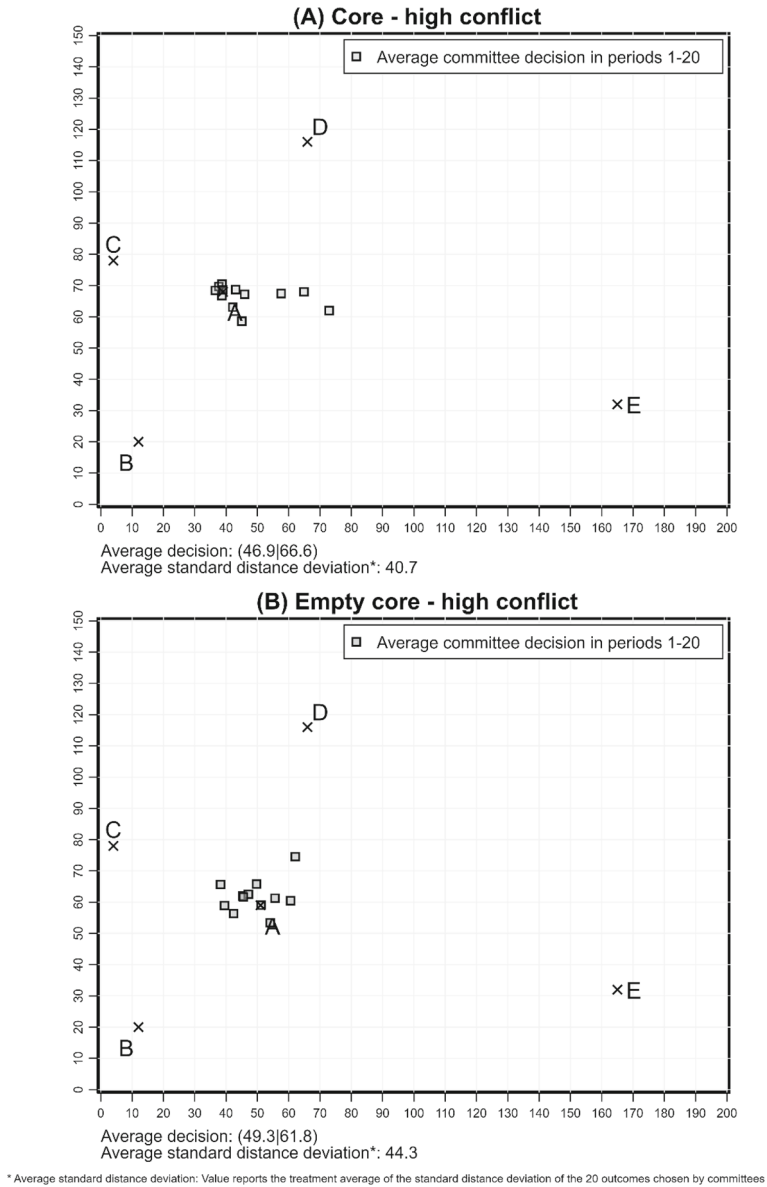
**Fig. 3** Majority rule instability in the low-conflict treatments

larger. Figure 3 shows majority rule instability in the two low-conflict treatments. In order to make systematic developments over time visible, I compare five-period averages.<sup>16</sup>

Overall, Fig. 3 confirms that decision-making is quite stable over time in both low-conflict treatments. In particular, an empty core does not lead to “chaotic” majority decisions. In contrast to the standard distance deviation, this alternative measure of instability reveals that an empty core somewhat increases instability of majority decision-making. The average distance between the chosen alternative and the status quo over all twenty periods in the Core—low conflict treatment is 6.0 units. The average distance in the Empty core—low conflict treatment is 9.4 units. A two-tailed Fisher–Pitman permutation test for two independent samples shows a significant difference between the two treatments ( $p = 0.055$ ). Splitting the experiment in five-period intervals indicates that meaningful differences only develop over time. In the Core—low conflict treatment, the average distance between the chosen alternative and the status quo is 12.8 units in periods 2–5 and decreases to about 4 units in the subsequent 15 periods of the experiment. In the Empty core—low conflict treatment, instability is rather stable at about 10 units throughout the whole experiment.

Overall, the two alternative measures of instability provide ambiguous evidence concerning the effect of the existence of a core in majority decisions under low conflict. Empirically, the effect is weak at best when conflict is moderate. According to Riker’s (1982) argument, the effect should become more prominent when conflict becomes more intense. Figure 4 shows the distribution of average decisions in the two high-conflict treatments. Similar to the low-conflict treatments, committees on average choose centrally located alternatives. The average decision is (46.9|66.6) in the Core—high conflict treatment and (49.3|61.8) in the Empty core—high conflict treatment.

<sup>16</sup> In period 1, the unattractive position of the status quo at the margin of the policy space, makes large shifts of the chosen point highly likely. Therefore, period 1 is omitted from the following analyses.



**Fig. 4** Average committee decisions in the high-conflict treatments

Contrary to Riker's argument the effect of the existence of a core does not become stronger under intensified conflict. The standard distance deviation of outcomes does not differ significantly between the Core—high conflict treatment and the Empty core—high conflict treatment (40.7 vs. 44.3,  $p = 0.693$ , two-tailed Fisher-Pitman permutation test for two independent samples).

As Fig. 5 shows, majority rule instability measured by the distance between the status quo and the chosen alternative in a period is considerably higher in the two high-conflict treatments compared to the low-conflict treatments. However, an empty core does not significantly increase instability under conflicting preferences. The average distance between the status quo and the chosen alternative in the Core—high conflict treatment is 24.9 points. Average instability in the Empty core—high conflict treatment is 27.5 points. The difference between treatments is not significant at conventional levels ( $p = 0.694$ , two-tailed Fisher-Pitman permutation test for two independent samples). In addition, breaking down the whole experiment into five-period intervals also reveals no significant differences between the two high-conflict treatments.

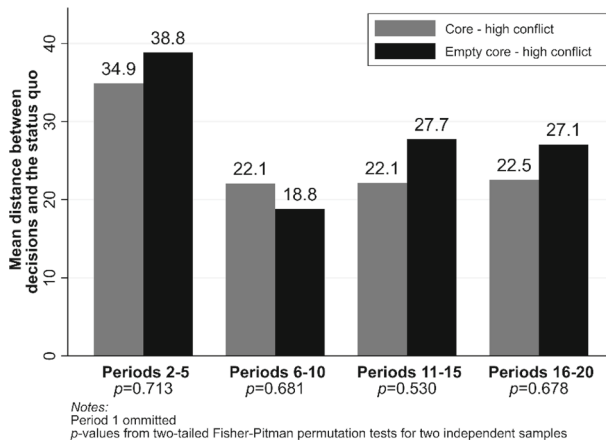
To sum up, the analysis of majority rule instability disconfirms Riker's argument that an empty core leads to greater majority rule instability when the level of conflict rises. In fact, an empty core does not lead to "chaotic" outcomes over time, and instead, the effect of increased conflict trumps the effect of the existence of a core. Hence, intensified conflict raises instability of majority decision-making regardless of whether the preference configurations induces an equilibrium or not. Moreover, the core seems to be less attractive than theoretically assumed because decision-making does not reach a stable state even in the later periods of the experiment in the core treatments—a finding deserving further attention.

## 4.2 Attraction of the core

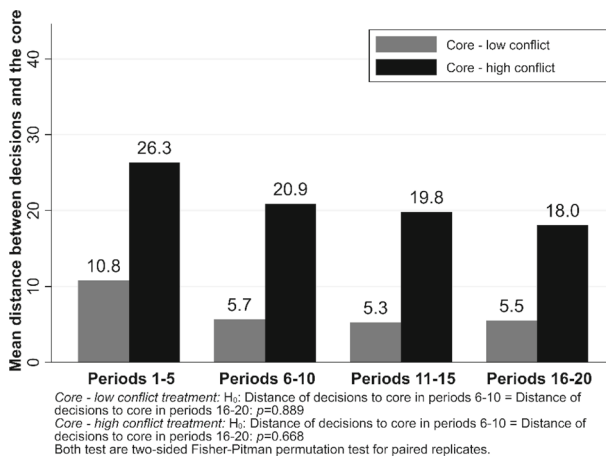
From the perspective of social choice theory, the apparently low attraction of the core is an unexpected finding. Only a minority of committee decisions result in the selection of the core alternative (39/68). In the Core—low conflict treatment, committees select the core in 35 out of 240 decisions (14.6%). In the Core—high conflict treatment, the success rate of the core is slightly higher. Fifty-five out of 240 decision (22.9%) end up in the predicted equilibrium. Looking at outcomes "close" to the core does not change the picture substantially. In the Core—low conflict treatment, 106 out of 240 decision (44.2%) lie within a radius of five units around the core. In the Core—high conflict treatment, 88 out of 240 outcomes (36.7%) are located within a radius of five units around the core.<sup>17</sup>

Figure 6 displays the development of the distance between chosen alternatives and the core over time. If an equilibrium exists, Plott's (1967) symmetry conditions imply that the winset of any given status quo only contains alternatives located closer to the core than the status quo. Hence, the distance between outcomes and the core should decrease over time in the experiment. However, results converge very slowly on the core at best. Between the first five periods and periods 5–10, the average distance of committee decisions to the core drops from 10.8 to 5.7 units in the Core—low conflict treatment and from 26.3 to 20.9 units in the Core—high

<sup>17</sup> Considering alternative operationalizations of "closeness" to the core supports the finding of a rather low attraction of the core. Thus, 182 out of 240 decisions (75.8%) fall within a radius of 10 units around the core in the Core—low conflict treatment. In the Core—high conflict treatment more than half of the decisions end up outside this radius. Only 106 out of 240 decisions (44.2%) are located within a rather large radius of ten units around the equilibrium.



**Fig. 5** Majority rule instability in the high-conflict treatments



**Fig. 6** Convergence on the core over time

conflict treatment. This initial convergence is probably due to the extreme location of the status quo at the margin of the policy space at the beginning of the experiment. However, in the following periods the distance between chosen alternatives and the core remains constant in the Core—low conflict treatment and decreases only very little in the Core—high conflict treatment. Thus, committee decisions do not converge significantly on the core between periods 6–10 and periods 16–20, and outcomes differ substantially from the core even in the last periods of the experiment.

Moreover, even if committees have once selected the core alternative they frequently leave it again in subsequent periods. In the Core—low conflict treatment, 8 out of 12 committees select the core in at least one period of the experiment. However, only a single group also selects the core alternative until the end of the experiment after its first selection. The seven other committees leave the core again.



The Core—high conflict treatment reveals a similar pattern. Seven committees choose the core in at least one period, but only two groups stick to the core throughout the remaining periods of the experiment whereas five committees leave the core again in later periods.

The analysis of the locations of committee decisions in the core treatments suggests a possible explanation for the low attraction of the core (see Figs. 3 and 4). In the Core—low conflict treatment the average chosen alternative (41.5|67.2) differs significantly from the core (39|68) along the  $x$ -axis.<sup>18</sup> However, the difference is substantially small. Similarly, in the Core—high conflict treatment committees choose on average alternatives significantly to the right of the core on the  $x$ -axis while deviations along the  $y$ -axis display no systematic pattern.<sup>19</sup>

In both core treatments, committees thus choose points significantly to the right of the predicted equilibrium. Social preferences offer a possible explanation for this behavior. Other experimental studies of committee decision-making show that material self-interest is not the only motivational factor of committee members' behavior. Instead, voters also take the well-being of other committee members into account. Hence, concerns about distributional fairness play an important role in majority decisions (Eavey 1991; Eavey and Miller 1984b; Sauermann 2016, 2018; Sauermann and Kaiser 2010). In both core treatments, E is the most disadvantaged member of the committee as her ideal point exhibits the greatest distance to the core. Hence, committees in the experiment possibly deviate from the core in the direction of E's ideal point in order to reach a fairer distribution of payouts in the game.

### 4.3 Individual behavior

The empirical analysis of the locations and dispersion of chosen alternatives reveals two findings deserving further attention. For one, an empty core does not lead to "chaotic" outcomes and secondly, the attraction of the core is lower than theoretically expected. In order to find an explanation for these patterns, I proceed by analyzing behavior of individual committee members. As explained above, the Romer–Rosenthal (1978) setter model provides predictions for expected strategic behavior of rational agenda setters and voters in the majority decisions. According to the model, agenda setters will propose alternatives from the winset of the current status quo that minimizes the distance to their own ideal points, and voters will vote for a proposal if it promises them at least as many tokens as the current status quo.

As a first step of the analysis, I compute the Romer–Rosenthal proposal, i.e. the optimal proposal for the agenda setter from the winset of the current status quo. In all four treatments, actual decisions of agenda setters differ substantially from the

<sup>18</sup>  $H_0$ :  $x$ -coordinate of 20-period average outcome in the Core—low conflict treatment = 39:  $p = 0.005$ , two-sided Fisher-Pitman permutation test for paired replicates.

$H_0$ :  $y$ -coordinate of 20-period average outcome in the Core—low conflict treatment = 68:  $p = 0.124$ , two-sided Fisher-Pitman permutation test for paired replicates.

<sup>19</sup>  $H_0$ :  $x$ -coordinate of 20-period average outcome in the Core—high conflict treatment = 39:  $p = 0.021$ , two-sided Fisher-Pitman permutation test for paired replicates.

$H_0$ :  $y$ -coordinate of 20-period average outcome in the Core—high conflict treatment = 68:  $p = 0.208$ , two-sided Fisher-Pitman permutation test for paired replicates.

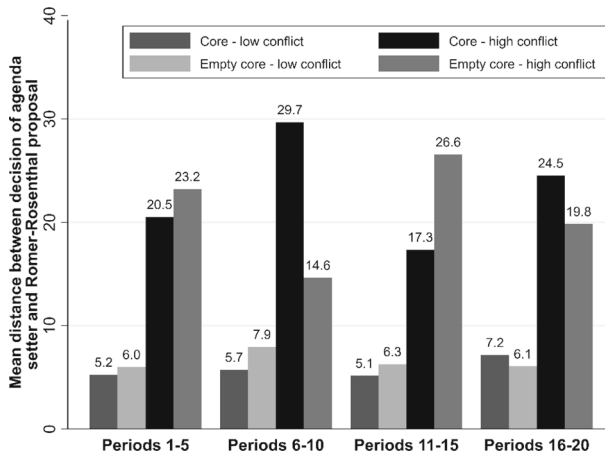
Romer–Rosenthal proposal. The average distance between agenda setters' decisions and the respective Romer–Rosenthal proposal amounts to 5.8 units in the Core—low conflict treatment, 6.6 units in the Empty Core—low conflict treatment, 23.0 units in the Core—high conflict treatment, and 21.1 units in the Empty Core—high conflict treatment. In all four treatments receiving agenda-setting power is still valuable as agenda setters can improve their payouts in comparison to the previous period with another group member in the role of the agenda setter. Payouts of group members in the Core—low conflict treatment improve by 51.0 tokens when they receive the right to make proposals. The agenda setter's advantage amounts to 77.3 tokens in the Empty core—low conflict treatment, 118.6 tokens in the Core—high conflict treatment, and 160.3 tokens in the Empty core—high conflict treatment. However, when individuals receive agenda-setting power in two consecutive periods, they are only able to improve their payoffs marginally by 10 tokens in the second period.

Overall, the experiment confirms a finding from Eavey and Miller (1984a) that agenda setters fail to fully exploit their theoretically predicted agenda-setting power. In addition, Fig. 7 shows that the optimality of agenda setters' proposals does not improve over time. In all four treatments, the distance between agenda setters' decisions and the Romer–Rosenthal proposal fluctuates unsystematically around the treatment's average value over time. Hence, rather than being able to impose their optimal alternative from the set of alternatives that are majority-preferred to the status quo, agenda setters have to compromise with the voting committee members.

As the second column of Table 1 shows, agenda setters frequently make proposals that hurt their own material self-interest. Thus, in 25% of all decisions, agenda setters propose an alternative offering themselves a lower number of tokens than the current status quo. As the experiment offers participants complete information about the payoff consequences of their decisions, it is highly unlikely that these proposals are due to subjects making mistakes. Moreover, most of the proposals against their own material self-interest come from Players A, B, C, and D, whereas Player E, the most disadvantaged Player, is much less likely to propose an alternative offering herself less tokens than the existing status quo. Again, social preferences offer a plausible explanation for this pattern as the more advantaged committee members try to realize a fairer distribution of payoffs among group members. Similarly, in 15.7% of all decisions, agenda setters propose alternatives outside the winset offering themselves more tokens than the optimal Romer–Rosenthal proposal (see column 3 of Table 1). In this case, most of these overreaching proposals stem from Player E, the most disadvantaged group member.

In comparison to behavior of agenda setters, behavior of committee members in the voting stage exhibits fewer deviations from the predictions of the Romer–Rosenthal (1978) setter model. In about 10% of all voting decisions, voters vote for the alternative offering them less tokens. In order to detect systematic patterns in the voting behavior, I estimate random-effects probit panel models. The dependent variable is a dummy indicating whether committees vote in favor of the agenda setter's proposal or reject the proposal and maintain the current status quo.<sup>20</sup>

<sup>20</sup> The analysis excludes 188 decisions in which agenda setters maintain the status quo without making a proposal.



**Fig. 7** Optimality of agenda setters' proposals

**Table 1** Agenda setter decisions

Treatment	Agenda setters assign themselves less tokens in their proposals in comparison to the current status quo	Agenda setter assign themselves more tokens in their proposals in comparison to the Romer–Rosenthal proposal
Core—low conflict	73/240 (30.4%)	47/240 (19.6%)
Empty core—low conflict	68/240 (28.3%)	51/240 (21.3%)
Core—high conflict	52/240 (21.7%)	13/240 (5.4%)
Empty core—high conflict	47/240 (19.6%)	40/240 (16.7%)

According to standard rational choice theory, committees will accept proposals in the winset of the status quo and reject proposals outside the winset. Hence theoretically, a single variable—location of proposals in the winset—fully explains voting decisions of committees. However, the analyses presented above provide evidence that behavior is also driven by social preferences. In order to test for a possible influence of other-regarding preferences in the voting decisions, I add additional independent variables. For one, I control for total group welfare and include a variable measuring whether the sum of tokens assigned to the committee as a whole is higher in the proposal in comparison to the status quo. Secondly, I control for distributional concerns. In model 1, I include a dummy indicating whether the standard deviation of the distribution of tokens is lower in the proposal than in the status quo. Model 2 employs an alternative measure of distributional

**Table 2** Random-effects probit model of acceptance of agenda setters' proposals

Dependent variable: acceptance of agenda setter's proposal (1: yes, 0: no)	(1)	(2)
Proposal in winset of status quo	1.428*** (0.152)	1.466*** (0.188)
Total number of tokens higher	0.426** (0.144)	0.365** (0.128)
Tokens more equally distributed	0.389** (0.135)	
Lowest number of tokens higher		0.291** (0.113)
Highest number of tokens higher		– 0.187 (0.199)
Core—high-conflict treatment	0.092 (0.231)	0.109 (0.233)
Empty core—low-conflict treatment	– 0.235 (0.228)	– 0.250 (0.224)
Empty core—high-conflict treatment	– 0.189 (0.164)	– 0.178 (0.158)
Constant	– 0.470** (0.176)	– 0.336** (0.162)
Observations	772	772

Random-effects probit models with heteroscedasticity-consistent standard errors in brackets.  
 \*\*\* $p < 0.001$ , \*\* $p < 0.01$

fairness. Dummy variables indicate whether the lowest payoff for a group member in the proposal is higher than the lowest payoff in the status quo alternative. Likewise, a second dummy measures whether the highest payoff for a committee member is higher in the proposal or not. Finally, models include treatment dummies to control for remaining treatment-specific effects.

Table 2 shows the regression results. As expected, being located in the winset of the status quo has a highly significant positive effect on the probability of the acceptance of a proposal in both models. However, the regressions also reveal an additional influence of other-regarding concerns on committee members' behavior. Hence, offering a higher total group payoff significantly increases the likelihood that groups accept proposals. Moreover, distributional concerns also affect voting decisions. Thus, model 1 shows that acceptance of proposals is more likely if a proposal offers a more equal distribution of tokens than the status quo. Model 2 reveals that committee members care especially for the welfare of the worst-off group member. If the proposal provides a higher payoff for the worst-off voter than the status quo, the acceptance of the proposal is more likely. Variation in the highest payoff of a group member, however, does not affect voting decisions significantly. Overall, the analysis of the voting decisions confirms that social preferences exhibit a significant influence in committee decisions.

## 5 Conclusion

Scholars disagree on the empirical implications of the McKelvey–Schiefelthorn theorems. For instance, Riker (1982) argues that the indeterminacy of majority rule leads to chaotic collective decisions and consequently, all democratic decisions lack meaning. Moreover, Riker argues that when the core is empty, majority rule instability increases with the level of conflict among group members. This study provides a comprehensive empirical test of both aspects of Riker's argument. The

experimental results provide overly disconfirming evidence for Riker's interpretation of the implications of the social choice theorems for democratic theory. Thus, an empty core does not lead to "chaotic" majority decisions cycling throughout the whole policy space. Instead, the effect of conflicting preferences trumps the effect of the existence of a core. The fact that the core exhibits less attraction than generally assumed is the second important finding of this study. Even though committees make repeated decisions for 20 periods, results do not fully converge on the core, and sometimes even diverge from the predicted equilibrium. Finally, the results show that the Romer–Rosenthal (1978) setter model has only limited predictive power, as agenda setters fail to fully exploit their proposal power.

The empirical analyses of this study provide evidence that the deviations of behavior from the predictions of traditional rational choice models exhibit a consistent pattern. Apparently, social preferences provide an additional motivational force of behavior in the majority decisions. Future research could investigate possible links between subjects' behavior and their political attitudes. Presumably, the influence of social preferences should be stronger among supporters of more left-wing policies.

Overall, this study contributes to a growing literature on the influence of other-regarding preferences in collective decisions (e.g. Eavey 1991; Eavey and Miller 1984b; Sauermann 2018; Sauermann and Beckmann 2019; Sauermann and Kaiser 2010). In other areas, such as collective action theory, empirical findings on the influence of social preferences have led to the development of new behavioral theories and thus greatly increased our understanding of social interactions (see Ostrom 1998, 2010). Possibly, incorporating these findings in the further development of social choice theory and democratic theory offers promising ways to advance our knowledge about the workings of voting mechanisms and democratic decision-making.

**Acknowledgements** Open Access funding provided by Projekt DEAL. I would like to thank Holger Reinermann for his excellent research assistance as well as participants of the 2016 annual meeting of the 'Arbeitskreises für Handlungs- und Entscheidungstheorie' for many helpful comments on the manuscript.

**Funding** This work has received generous funding from the Fritz Thyssen Foundation (Az. 20.12.0.075). Financial support from the German Research Foundation (DFG) for the Cologne Laboratory for Economic Research is also gratefully acknowledged.

## Compliance with ethical standards

**Conflict of interests** The author declares that there is no conflict of interest.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## References

- Arrow, K. J. (1963). *Social choice and individual values* (2nd ed.). New Haven: Yale University Press.
- Austen-Smith, D., & Banks, J. S. (1999). *Positive political theory. I. Collective preference*. Ann Arbor: University of Michigan Press.
- Bianco, W. T., Lynch, M. S., Miller, G. J., & Sened, I. (2006). "A theory waiting to be discovered and used": a reanalysis of canonical experiments on majority rule decision-making. *Journal of Politics*, 68(4), 838–851.
- Black, D. (1948). On the rationale of group decision making. *Journal of Political Economy*, 56(1), 23–34.
- Browne, E. C., & Hamm, K. E. (1996). Legislative politics and the paradox of voting: electoral reform in the Fourth Republic France. *British Journal of Political Science*, 26(2), 165–198.
- Condorcet MDDC, Nicolas MJA (1785/1995) An essay on the application of analysis to the probability of decisions rendered by a plurality of votes. In McLean I, Urken AB (Eds.), *Classics of social choice*. University of Michigan Press, Ann Arbor, pp 91–112.
- Cox, G. W., & Shepsle, K. A. (2007). Majority cycling and agenda manipulation: Richard McKelvey's contributions and legacy. In J. H. Aldrich, J. E. Alt, & A. Lupia (Eds.), *Positive changes in political science. The legacy of Richard D. McKelvey's most influential writings* (pp. 19–40). Ann Arbor: University of Michigan Press.
- Davis, O. A., DeGroot, M. H., & Hinich, M. J. (1972). Social preference orderings and majority rule. *Econometrica*, 40(1), 147–157.
- Eavey, C. L. (1991). Patterns of distribution in spatial games. *Rationality and Society*, 3(4), 450–474.
- Eavey, C. L., & Miller, G. J. (1984a). Bureaucratic agenda control: Imposition or bargaining? *American Political Science Review*, 78(3), 719–733.
- Eavey, C. L., & Miller, G. J. (1984b). Fairness in majority rule games with a core. *American Journal of Political Science*, 28(4), 570–586.
- Endersby, J. W. (1993). Rules of method and rules of conduct: an experimental study on two types of procedure and committee behavior. *Journal of Politics*, 55(1), 218–236.
- Fiorina, M. P., & Plott, C. R. (1978). Committee decisions under majority rule: an experimental study. *American Political Science Review*, 72(2), 575–598.
- Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, 10(2), 171–178.
- Greiner, B. (2015). Subject pool recruitment procedures: Organizing experiments with ORSEE. *Journal of the Economic Science Association*, 1(1), 114–125.
- Hinich, M. J., & Munger, M. C. (1997). *Analytical politics*. Cambridge: Cambridge University Press.
- Laing, J. D., & Olmsted, S. (1978). An experimental and game-theoretic study of committees. In P. C. Ordeshook (Ed.), *Game theory and political science* (pp. 215–281). New York: New York University Press.
- Lasswell, H. D. (1936). *Politics: Who gets what, when, how*. New York: Whittlesey House.
- Mackie, G. (2003). *Democracy defended*. Cambridge: Cambridge University Press.
- McKelvey, R. D. (1976). Intransitivities in multidimensional voting models and some implications for agenda control. *Journal of Economic Theory*, 12(3), 472–482.
- McKelvey, R. D. (1979). General conditions for global intransitivities in formal voting models. *Econometrica*, 47(5), 1085–1112.
- McKelvey, R. D., & Ordeshook, P. C. (1984). An experimental study of the effects of procedural rules on committee behavior. *Journal of Politics*, 46(1), 182–203.
- McKelvey, R. D., Ordeshook, P. C., & Winer, M. D. (1978). The competitive solution for n-person games without transferable utility, with an application to committee games. *American Political Science Review*, 72(2), 599–615.
- Miller, N. (1980). A new solution set for tournament and majority voting. *American Journal of Political Science*, 24(1), 68–96.
- Morton, R. B., & Williams, K. C. (2010). *Experimental political science and the study of causality: from nature to the lab*. Cambridge: Cambridge University Press.
- Ostrom, E. (1998). A behavioral approach to the rational choice theory of collective action [Presidential Address, American Political Science Association]. *American Political Science Review*, 92(1), 1–22.
- Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. *American Economic Review*, 100(3), 641–672.

- Plott, C. R. (1967). A notion of equilibrium and its possibility under majority rule. *American Economic Review*, 57(4), 787–806.
- Riker, W. H. (1980). Implications from the disequilibrium of majority rule for the study of institutions. *American Political Science Review*, 74(2), 432–446.
- Riker, W. H. (1982). *Liberalism against populism. A confrontation between the theory of democracy and the theory of social choice*. San Francisco: W. H. Freeman and Company.
- Riker, W. H. (1986). *The art of political manipulation*. New Haven and London: Yale University Press.
- Romer, T., & Rosenthal, H. (1978). Political resource allocation, controlled agendas, and the status quo. *Public Choice*, 33(4), 27–43.
- Sauermann, J. (2016). Committee decisions under majority rule revisited. *Journal of Experimental Political Science*, 3(2), 185–196.
- Sauermann, J. (2018). Do individuals value distributional fairness? How inequality affects majority decisions. *Political Behavior*, 40(4), 809–829.
- Sauermann, J., & Beckmann, P. (2019). The influence of group size on distributional fairness under voting by veto. *European Journal of Political Economy*, 56, 90–102.
- Sauermann, J., & Kaiser, A. (2010). Taking others into account: self-interest and fairness in majority decision making. *American Journal of Political Science*, 54(3), 667–685.
- Schofield, N. (1978). Instability of simple dynamic games. *Review of Economic Studies*, 45(3), 575–594.
- Shepsle, K. A. (1979). Institutional arrangements and equilibrium in multidimensional voting models. *American Journal of Political Science*, 23(1), 27–59.
- Shepsle, K. A., & Weingast, B. R. (1981). Structure-induced equilibrium and legislative choice. *Public Choice*, 37(3), 503–519.
- Smith, V. L. (1976). Experimental economics: Induced value theory. *American Economic Review*, 66(2), 274–279.
- Stratmann, T. (1996). Instability of collective decisions? Testing for cyclical majorities. *Public Choice*, 88(1/2), 15–28.
- Wilson, R. K. (1986). Forward and backward agenda procedures: committee experiments on structurally induced equilibrium. *Journal of Politics*, 48(2), 390–409.
- Wilson, R. K. (2008). Endogenous properties of equilibrium and disequilibrium in spatial committee games. In C. R. Plott & V. L. Smith (Eds.), *Handbook of experimental economics results* (Vol. 1, pp. 873–879). North-Holland: Elsevier.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.