A Microfoundation of Centrifugal Dynamics in Party Systems

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Abstract:
When explaining the polarization of party systems, Satori’s (1976) typology represents one of the central concepts. Here the direction of party competition is affected by an occupied political center and a bilateral opposition. The macro-level explanans and explanandum are based on the behavior of parties and voters. A party system will only polarize if the voting behavior and/or the party positions change. Thus, the following research question arises: Which influences on actors in party competition determine the correlation on the macro-level?

In the first step the link between coalition formation and the behavior of parties and voters is discussed. In the logic of Sartori the accountability of coalition parties, the cooperation of parties and the possible dissatisfaction of voters with governing parties are plausible factors. Secondly, these causal mechanisms are tested in an agent-based model.

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Introduction

Ever since the work of Sartori (e.g. 1966, 1976) polarization is established as a key feature of party systems. An adverse influence of this attribute is discussed in political science literature. Correlations with cabinet-survival, political stability and other characteristics of political systems were found in empirical analyses (in summary Curini & Hino 2012: 460f.). Further Dalton (2008: 900) assumed polarization to be the reason behind the breakdown of several democracies, e.g. the Weimar Republic or the French Fourth Republic. In addition Sani and Sartori (1983: 337) summarized their empirical findings as follows: “All told, this chapter suggests [...] that the best single explanatory variable for stable versus unstable, functioning versus non-functioning, successful versus immobile, and easy versus difficult democracy is polarization.”

However, when we assume that polarization is a notorious element in explaining adverse developments in political systems, it is necessary to consider centrifugal dynamics that lead to polarization in the first place. The two central theoretical concepts dealing with competition dynamics are Downs’ economic theory (1957) and the typology of Sartori (1976) (in summary Green-Pedersen 2004: 325). Nevertheless, there is a crucial difference between both approaches. On the one hand Downs explains the behavior of parties and voters in the tradition of Rational Choice Theory. Sartori’s concept on the other hand is located at the macro level. Thus, his definition of party competition includes the whole party system: “Competition is a structure, or a rule of the game” (Sartori 1976: 218).

In this typology party systems are distinguished based on their fragmentation and polarization level. Each type contains a mechanics of interparty competition. The level of polarization changes between the two types of multiparty systems: moderate and polarized pluralism. Sartori (1976: 132-140, 179) describes the mechanics of both types with eight opposed traits. The differences, which could cause a specific dynamic, are a bilateral opposition and an occupied ideological center. I argue that the other described features represent results and not reasons of a polarized competition. Examples are the existence of anti-system parties and the ideological patterning. Up to this point, the explanation is just a macro-level correlation. Although, the system attributes are based on the behavior of actors. Indeed, the author also discusses theoretical assumptions about voters and parties, but there is only a diffuse linkage between the different analytical levels. However, any precise logic of situation or aggregation is not part of the typology.1

1 Actually, Sartori (1976: 351) itself demands a model of polarized party competition: “The point remains that we do need a model which accounts for the competitive trends of the “unstable,” non-working democracies”.1
In contrast, studies of party competition in the tradition of Down’s economic theory show a wide range of (formal) models, which test effects of actor-level assumptions (e.g. Budge 1994, Adams 2001, Cox 1990). In the majority of cases these models work with analytical solutions. Unfortunately, there are several restrictions of the method like analytical solvability and the necessity of (static) equilibria (Laver & Sergenti 2012: 4-10, Railsback & Grimm 2012: 9 ff., Flache & Macy 2006: 540). Thus, analytical models are often limited by the method. For example, these restrictions affect the possible number of different parties, the actors’ heterogeneity or the information level (Laver & Sergenti 2012: 4-10, Martin 2009: 47-49, Hermens & Verbeek 1992). Problems will occur, if there are unrealizable assumptions in the theoretical concept.

This might be the main problem, when working out a logic of aggregation in Sartori’s theory. On the one hand he discusses heuristics like preference voting or vote-seeking parties with reference to Downs, which are relatively easy to model. On the other hand he also assumes more complex behavior patterns in party competition. For example, he integrates the accountability and cooperation of (governing) parties and party identification of voters in his theoretical concept. However, it is not possible to leave out these ‘complex’ assumptions because they are absolutely essential to the typology.

But a growing number of party competition studies use an alternative method: Agent-based (simulation) models. For example, Laver and Sergenti (2012) test the impact of different party heuristics with such a model. Because of the missing limitations, their models include assumptions with complex heuristics like different kind of aims (policy- vs. vote-seeking) or different strategies. In addition there are multiparty systems and two ideological dimensions in this study. Furthermore, a lot of simulation studies show new possibilities to model theoretical assumptions (e.g. Plümper & Martin 2008, Shikano 2009, Schreiber 2014). Thus, this new method may allow linking both fields of research: the (formal) models of party competition based on actors in the tradition of Downs and the macro theory of Sartori. Therefore the purpose is to find a (theoretical possible) microfoundation of the correlations in the typology. That is why, the following research question arises:

Which influences on actors determine the effect of a bilateral opposition and an occupied center on an increasing polarization in party competition?

In this paper I outline Sartori’s approach of moderate and polarized pluralism to clarify the macro-level explanation. I argue that the cause, which explains the centrifugal dynamics, is the coalition type. Further, Sartori’s assumptions of voter and party behavior are discussed. With references to Coleman’s bathtub model, I try to figure out possible theoretical macro-
micro- and micro-macro-links. In this non-formal step, the purpose is to deduce predictions of possible microfoundations in the logic of Sartori’s theory. Next, the validity of these presumptions is tested in an agent-based simulation. Because of the complex and dynamic characteristics of party competition models, the predictions have to be tested in order to assure the logical consistency of the theoretical assumptions. The results show interesting correlations. Center coalitions do not cause a centrifugal push, wing coalitions prevent such a dynamic. In addition, the cooperation of opposition and coalition parties is the most important mechanism on actor-level. Lastly, these findings are discussed with reference to the current state of research in political science.

The theoretical approach of Sartori: types, voters and parties

Sartori’s typology has undoubtedly a significant influence on party system studies (e.g. Mair 1997: 202, Broughton & Donovan 1999: 5, Pelizzo & Babones 2007: 53). Here, party systems are distinguished on the basis of fragmentation and polarization (Sartori 1976: 125-129). A theoretical important purpose of the typology is to explain the direction of competition (e.g. Sartori 1976: 289; in addition Ware 1996: 179, Evans 2002: 163). Sartori discusses two kinds of dynamics: a centrifugal and a centripetal drive (Sartori 1976: 123). Because of Sartori’s (1976: 136, 179) descriptions, these dynamics can be defined as follows: First, a centrifugal dynamic includes an increasing polarization and extremisation on a dominant ideological dimension and second, a centripetal dynamic includes a decrease of these attributes.

Moreover, a crucial point is that the types are not only analyzed in an isolated way. Sartori also outlines relations between these different types. Hence, the typology is arranged in a simplified one-dimensional scheme (Sartori 1976: 128) and in a more complex framework (ibid.: 273-293). There are two ideas of this intertype perspective: First, the type of party systems can change over time. In democratic systems, this development depends solely on elections and party competition. A two-party system evolves into a multiparty system due to a third party’s success. Second, the sequence of party system change is predefined in a probabilistic sense. For example, the following order of change could be theoretically supposed: First a two-party system evolves into a system of moderate pluralism, next into a

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2 Indeed, there are criticisms of the approach (e.g. Stöss et al. 2006: 10, Detterbeck 2011: 150f., Kneisler 2011: 41ff.). Further, newer typologies (e.g. von Beyme: 2000, Niedermayer: 2008, Ware: 1996) are discussed. However, these alternatives approaches do not take up the theoretical framework and are reasoned empirically.

3 Sartori (1976: 274f.) discusses also discontinuous changes like breakdowns and revolutions. Here, I concentrate on continuous changes.
system of polarized pluralism and final into an atomized party system. In contrast, a direct development of a two-party system into an atomized system is unlikely.

Referring to the research question, the change of competition direction is in demand. This mechanics shifts between the adjacent types moderate and polarized pluralism (Sartori 1976: 289). In systems of moderate pluralism polarization is low, due to a centripetal tendency. In contrast, polarized pluralism is characterized by a centrifugal dynamic and a high polarization. But which differences account for the divergent dynamics of competition?

First of all, this question may be met with the argument that the number of parties is the crucial point and surely this is an important element of the typology (e.g. Sartori 1976: 120). According to Sartori (1976: 131) a probable turning point occurs in systems with five to six parties. But in the theoretical concept the number of parties is not the cause of a change in dynamic. Sartori argues that the fragmentation leads to different opportunities in the system, e.g. the possible number of interaction links or the necessity of coalitions (Sartori 1976: 120). Therefore, the format of competition is determined by the numeric criterion. Nevertheless, this factor cannot explain the mechanics: “It is evident, therefore that there is something that counting cannot detect and yet is essential” (Sartori 1976: 126). I argue that the number of parties is a necessary condition in the logic of Sartori: A two-party system would not polarize in theory, but the dynamic of a five-party system could be centripetal or centrifugal.

In addition, Sartori describes six more characteristics of polarized and moderate pluralism, which could explain the different direction of dynamic. In contrast to the moderate type, the following characteristics occur in polarized pluralism: (1) The structure of opposition is bilateral. Thus, a governing coalition competes with parties on both ideological ends. (2) The ideological center is occupied by a party or a coalition of parties. Therefore, the parties do not compete for center voters. (3) There are anti-system parties, which do not oppose on issues, but on principle. (4) The rules of competition are undermined and politics are characterized by outbidding one another. (5) Because of an ideological patterning, there are fundamental disagreements between the parties. (6) An irresponsible opposition asserts pressure on the coalition with unfulfillable demands (Sartori 1976: 134-140).

Points three through six seem to be a result and not a cause of polarization. In Sartori’s argumentation parties oppose on principle because of the missing chance of government participation. In addition, such parties can demand irresponsible claims for the same reason (ibid.). But how can we explain that such parties cannot be part of a governing coalition? As a result of the high polarization, there have to be parties who are not relevant for any feasible coalition, because their ideology differs significantly from other parties. Therefore, these
points are best described as features of a polarized competition. In contrast, Sartori argues that a bilateral opposition and an occupied center cause a centrifugal dynamic (Sartori 1976: 135f.):

Figure 1: The causal chain in polarized pluralism

If an occupied center and a bilateral opposition determine a specific structure of competition, which causes a centrifugal dynamic, one question arises: When does such a structure occur in party systems? One explanation can be the coalition formation.4 If the number of parties in a competition is higher than three, there will be two possible types of coalition: a center or a wing coalition. Systems with a center coalition are characterized by an opposition on the left and right. Simultaneously, there are only coalition parties at the ideological center. In contrast both characteristics do not exist in systems with wing coalitions. Here, the opposition has a unilateral structure and opposition parties as well as coalition parties are positioned at the center: The center is not occupied. Therefore, center coalitions should induce centrifugal dynamics.

Unfortunately, the causal explanation in the theoretical concept seems to be incomplete. Up to this point, the causal relation is only placed at macro-level. The coalition type and the competition dynamic are characteristics of a party system, but both features are linked with the actor-level. The coalition type determines the coalition status of each party in the system and the polarization depends on parties’ ideological positioning and voters’ voting behavior.5 Thus, polarization is an aggregated feature per definition. Hence, the causal chain is

4 The underlying idea goes back to Simon T. Franzmann.
5 There are different formalizations of polarization in political science literature (e.g. Sigelman & Yough 1978, Taylor & Herman 1971). But most of them include vote share and the ideological position of parties. In the following, I use the Dalton’s Index (Dalton 2008).
interrupted and we are presented with a black box. This problem can be outlined referring to Coleman’s macro-micro-macro-model:

Figure 2: The black box

To explain the correlation between coalition type and competition dynamic, the logic of selection of parties and/or voters has to be affected by the logic of situation. Indeed, Satori (1976: 324-351) discusses voting and positioning behavior referring Downs and Stokes etc., but he fails to link these assumptions with his typology. To complete the causal chain, a concept of actors’ behavior (logic of selection) and an assumed influence of coalition types on actors (logic of situation) are needed.

Referring to parties’ logic of selection, Sartori argues that parties can pursue different goals. Nevertheless, they are vote-maximizers at elections. His argument is that electoral power is just a necessary condition for achieving other goals (Sartori 1976: 327). Surely, this is a shortened theoretical concept of party aims. Regarding Strøm’s (1990) model, the motivation of policy- and office-seeking completely lacks in this argumentation. But the first step should be to explain the macro-macro-correlation in logic of Sartori’s theory. Therefore, party positioning is explained by vote-seeking aims. However, there are some exceptions in the theory. First of all, accountability is an essential part of Sartori’s description of polarized competition. Some parties, especially anti-system parties, are not bound by a possible governmental responsibility. They can claim anything without regarding the realistic opportunity to realize these demands (Sartori 1976: 138f.). The inversion of this argument is that other parties, especially governing parties, are bound by some kind of accountability. In the simplest case, they cannot be part of a (governing) coalition and have also an anti-constitutional programmatic. Regarding Sartori’s definition of relevance (ibid.: 122-124), parties can either have a coalition or a blackmail potential. Thus, governing parties will not compete for ideological extreme positions.
The second exception is the possibility of cooperation. Sartori argues that a coalition of parties can occupy the ideological center, which “implies that the central area of the political system is out of competition” (Sartori 1976: 135). As a result, this also means that these coalition parties cooperate. The reason is simple: the ideological center will only be out of competition, if center parties do not compete for a center voter population. To achieve this, parties of a center coalition have to cooperate. Hence, the concept of competition ought to contain two ways of interaction: to compete or to cooperate.6

Furthermore, Sartori (1976: 328-334) discusses three kinds of voter concepts: identification-, issue- and image-voting. In the first concept, the voter chooses a party because of his personal identification. This mechanism implies a highly constant voting behavior. The author discusses the cause of identification with a specific party only superficially. Still he identifies two features that are relevant to a model of competition. (1) Identification does not change regularly and (2) there is a connection between policy preferences and such identification. Next, the concepts of issue- and image-voter are related. In both theories, the voter makes a decision because of the congruency between his own political position and the parties’ positions. Thus, the similarity is the voting based on a preference. But the first one is grounded on issue positions and the second one on ideological positions. Of course, both types of voters have to have two abilities: They have to be able to perceive the issue or ideological positions of parties and to assign themselves to a certain position. Further, they favor the party with the least disparity to themselves.

Sartori argues that there are party systems with only one ideological dimension. Although there are cases, in which a one-dimensional concept does not work. But in multiparty systems, the necessity of a cost reduction increases and the probability of an ideological left-right dimension rises. Further, a dominant, ideological dimension is simply a necessary condition of polarization (Sartori 1976: 334-342).7

Therefore, the concept of image voters is the relevant concept in an analysis of centrifugal dynamics. As a result, there are two ideal types of voting behavior in polarized competition according to Sartori’s concept: the image- and the identification-voter. Usually voters are located between these extreme points. They have an ideological preference and an identification bias in favor of specific parties. However, a crucial point remains: (ideological) preferences are not only formed exogenously. Sartori (1976: 28f.) argues that parties do not

6 Franzmann (2011: 320) extends the competition concept of Sartori in the same way. In his framework, competition and collusion are macro-level states. Contest and cooperation are possible interactions of parties. In contrast, Bartolini (1999: 438f) assumes that competition is a logic of selection.

7 Alternatively high fragmented party systems will become segmented, if there isn’t any ideological dominant dimension (Sartori 1976: 341).
articulate unbiased political messages. Instead they try to channel and select specific issues. Thus, parties can use their expressive function to influence voters or – according to Sartori – even deliberately indoctrinate them (ibid.: 137f.).

To summarize, the concepts of vote-seeking parties on party-level and image- and identification-voters on voter-level are the basic theoretical assumptions about the behavioral patterns in party competition. But these concepts do not suffice as an explanation for the macro-level correlation since there is no theoretical element that includes a different logic of situation due to the coalition type. Thus, a center coalition compared with a wing coalition would not cause a different behavior of any actor in the theoretical model. But the three exceptions of these assumptions - cooperation, accountability and endogenous preference formation – may hold a solution:

(1) Sartori’s central argument is that an occupied center causes a centrifugal push. Therefore, the cooperation of the center coalition parties could be an explanation based on actors. If both central parties (e.g. party B and C fig. 3) do not compete with each other, the central voters are not in the focus of competition. Thus, these (vote-seeking) parties (B and C) will compete for moderate voters. There is no alternative without challenging their coalition partner. This move of party B and C can affect the possibilities of the moderate opposition parties (e.g. especially party D). If the coalition party wins (moderate) voters originally belonging to opposition parties – e.g. because of an identification bonus - , the opposition parties have to attract extreme votes to survive. Thus, the missing concentration on center voters of cooperating coalition parties may cause a chain of reactions in party competition, which results in an increased polarization:

**Figure 3: The push of center coalitions**

Additionally, the cooperation of party B and C may prevent a shift to the ideological center of another party (e.g. party D), because this party would have to challenge two cooperating parties at once. Therefore, the center coalition induces a centrifugal push and prevents a moderate shift:

*Prediction 1: Because of the cooperation of coalition parties and (ideological consistent) opposition parties center coalitions cause a centrifugal dynamic.*
(2) Another exception to vote-maximizing behavior is the accountability of coalition parties. Indeed, this limitation should not affect party competitions with a center coalition, because there are not incentives for the coalition parties to occupy extreme positions. But the accountability may prevent centrifugal drives of a wing coalition. For example, if there is no party on the left of the coalition and these coalition parties are not able to shift to extreme positions, a centrifugal competition on the left will be unlikely. Thus, the chance of polarization is reduced:

Prediction 2: Because of the accountability of coalition parties wing coalitions decrease the chance of centrifugal dynamics.

(3) Lastly, the assumption of endogenous preference formation has to be discussed. Without any further considerations, this factor should not contribute to the correlation between coalition type and competition dynamics. A uniform distribution of influence on voters should reduce the chance of any dynamic, because this mechanism enforces the link between voters and their preferred party. If the chance of winning new voters is reduced or even eliminated, a vote-seeking party does not have any incentive to change its ideological position. But there are two arguments that suggest that the influence on a voter is not distributed uniformly. First, Sartori (1976: 137f.) argues that indoctrination of voters could be a strategy of specific parties. Here, the author specifically mentions nationalistic and communistic parties. Thus, parties with an extreme ideology seem to have a firmer influence on voters. This mechanism could enforce the centrifugal dynamics of center coalitions. If there is (only) a moderate shift due to cooperation and accountability, the mechanism of endogenous preference formation can initiate a cycle of polarization:

Prediction 3: Because of the particular influence of extreme parties on voters, the centrifugal dynamics of center coalitions caused by the mechanism of cooperation and accountability is increased.

Obviously, this mechanism does not explain the genuine influence of center coalitions on competition dynamics. Instead an interaction effect is assumed. But there is a second potential mechanism following Sartori’s logic, which regards the endogenous preference formation and the accountability of governing parties: (4) Because of the accountability for a certain policy, coalition parties risk to disappoint their own voters. At the same time (some) opposition parties can make exorbitant promises (referring the outbidding politics) and influence these disappointed voters. Thus, this mechanism suggests a flow of voters to ideological positions of the opposition. Surely, a necessary condition of such an effect would be a crisis. Therefore,
government parties have to make tough decisions. The mechanism effects the distribution of voters in different ways depending on the coalition type:

Figure 4: Different electoral shifts

Accordingly, dissatisfaction of coalition voters will increase the number of center voters, if there is a wing coalition. An opposite effect can be assumed in a center coalition:

*Prediction 4: Because dissatisfaction with government parties, center coalitions initiate a centrifugal dynamic.*

The agent-based model

Agent-based modeling is surely not a common method in the social science (Squazzoni 2010) and there are crucial differences compared with analytical models (Laver & Sergenti 2012: vi-xii, Railsback & Grimm 2012: 9-11). For this reason, I want to summarize the approach’s basics to allow a better understanding of the results. Further, I outline the model of this paper and the implementation of the theoretical assumptions in the object-oriented programming language.\(^8\) Lastly, I describe my analytical approach in detail. There are some specific disadvantages of agent-based simulations, like the problem of inductive reasoning. Thus, it is important to find a suitable method. I argue that a combination of regression analysis and qualitative comparative analysis helps to understand the results.

Two main features of the modeling approach are most important in comparison to analytical models: the object-oriented logic and the usage of a computational approach (e.g. Gilbert 2008, Railsback & Grimm 20012: 9-12, Flache & Macy 2006). In agent-based models, individuals are embedded in contexts, which are part of a dynamic process. This may be a simple observation, but it is of great consequence. It means that actors are autonomous units in the model. For example, if I assume that a party has a specific goal (e.g. vote-, office- or policy-seeking) or trait (e.g. ideological position), each party in the model will have these attributes independent of others parties: actors are objects in the logic of object-oriented

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\(^8\) The source code can be found in the appendix (see fig. 12). Because of the advantages, I use NetLogo. Indeed, agent-based models can be realized in all object-oriented languages, but there are specialized environments, which simplify the realization. On the one hand, NetLogo has a detailed documentation and a large community. On the other hand, it is widely used in scientific studies (Thiele et al. 2012). In political science, Laver and Sergenti (2012) recently published an agent-based model of party competition in NetLogo.
language. Therefore, this approach does not realize a model as if there were actors. Here, each voter or each party is included as an autonomous object. An advantage of this procedure is the possibility to realize complex theoretical assumptions like heterogeneous actors or learning abilities (e.g. Gilbert 2008: 6-16). A disadvantage can be the increasing complexity of a model.

Next, actors are not completely independent, but bound by their context: They act in the same environment. The effects and the kind of context depend on the theoretical assumptions, but it is possible to realize a geographical space as well as an ideological dimension (e.g. Gilbert 2008: 26 f.). In the programming language, the context could for example consist of global variables or functions. There are many possibilities to implement a context into the model. Hence, the approach can model multilevel processes with a variety of different and heterogeneous actors. The behavior of these agents is not limited by the approach. It can be reactive or proactive and include interactions with other agents (ibid.: 21f.). Furthermore, an iterative process is part of the model (ibid.: 28-30). Therefore, a sequence of actions and choices is repeated a defined number of times.

Thus, the approach goes further than a mathematical equation and has more possibilities, because of the programming language. For that reason, a problem arises. Analytical solutions are normally not possible in agent-based models. Thus, on the one hand, the advantage is that an analytical solvability is not necessary, which is why many restrictions are dropped out. But on the other hand, the disadvantage is that there are no analytical solutions derivable. The alternative way is to compute results of specific parameter constellations - so a simulation approach is used to solve this problem. But the crucial restriction of these computational results is a lack of general validity (Laver & Sergenti 2012: vii-xii).9 Thus, each result is only valid for the specific parameter input. Nevertheless, such analyses usually aim at deriving general conclusions. This can be a tough problem, because a few model parameters already cause a large number of possible input constellations. Therefore, the parameterization becomes an important part of research design. Broadly speaking, there are two different ways: a systematic and a random parameterization (ibid.: 57-61). Surely, the choice depends on the requirements of the specific model. Hence, I outline the formal model in the following.

Regarding the translation in a formal model, I pursue two aims: First, I try to reduce the number of parameters to reduce the complexity of the outcome. Second, all model parameters and their range of values should be interpretable and distinguishable with regard to the theoretical concept. Therefore, I focus, for example, on three ideal types of possible

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9 For that reason, it will always be better to aim for an analytical solution, if it is possible (Laver & Sergenti 2012: vii-xii).
identification distributions. Because of the theoretical concept, the following points have to be realized in the agent-based model: (1) an ideological dimension, (2) different initial situations of competition (number and ideological positions of parties, distribution of voters, types of coalitions), (3) the dynamic processes of competition (sequence of an iteration), (4) the behavior of parties (vote-seeking, accountability and cooperation), (5) the behavior of voters (image- and identification-voters, endogenous preference formation, potential dissatisfaction), (6) the measurement of competition dynamics.

(1) The ideological dimension is implemented as a one-dimensional space ranging from -100 to +100. At each point of time, parties and voters have one individual position on this scale. Because there aren’t any assumptions about a varying size in the theoretical concept, it is constant in all iterations and repetitions. Further, because of the uneven number of points, there is a metrical ideological center.

(2) Of course, the distribution of ideological positions of parties could be completely randomized without any defaults. Thus, in the model every thinkable constellation would be possible. But this would go beyond the scope of a purposeful analysis. For this reason, I focus on a few types of constellations, which can be theoretically distinguished. First, Sartori argues that a change of competition dynamics could be suspected in party systems with five or six parties. In contrast, a party competition with four parties should produce similar patterns to two-party systems (Sartori 1976: 348). Therefore, the number of parties ranges from four to six and there can be a center or a wing coalition in each case. As a result, there are six possible constellations:

Figure 5: Six different initial situations of competition

<table>
<thead>
<tr>
<th>coalition / parties</th>
<th>center coalitions</th>
<th>wing coalitions</th>
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<tbody>
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<td>4</td>
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<td>6</td>
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The starting distance between the parties is homogeneous and is determined by an input parameter. The possible range is between 15 and 35. Thus, the constellation of competition can be captured by just two parameters. At the beginning the party system is always centered on the ideological center.
In models of party competition, two ideal types of voter distributions are particularly interesting: uni- or bimodal distributions (e.g. Caramani 2011: 254). If the theoretical assumption contains vote-seeking parties, these different types of distributions will induce different dynamics. However, an occupied ideological center should induce centrifugal dynamics independently of voter distributions. Therefore, the expectation regarding a party system with a center coalition is an increasing polarization, even if there is a unimodal (and moderate) voter distribution. In contrast, a bimodal electorate should cause a polarized competition without any centrifugal push of center coalitions. Surely, Sartori’s argumentation focuses on this kind of explanation (Sartori 1976: 131-185, 342-351), but a second effect is also discussed: Wing coalitions with an ideological consistent opposition have a centripetal influence on the dynamic (ibid.: 179). Thus, there are two possible causal chains:

- (Moderate preconditions → ) center coalition → centrifugal competition
- (Non-moderate preconditions → ) non-center coalition → centripetal competition

A crucial difference must be stressed: First, center coalitions are a sufficient condition of centrifugal dynamics. Second, center coalitions are a necessary condition of centrifugal dynamics. This means, if both cases are true, center coalitions will be a necessary and sufficient condition. In the first analysis, I concentrate on different unimodal distributions to test the hypothesis of a centrifugal push. In a second analysis, the competition is simulated with a bimodal distribution.¹²

¹¹ Sartori (1976: 348f.) describes especially this effect referring four-party systems.

¹² In the case of a unimodal distribution, the voter’s distribution is a normal distribution with a mean of zero. The standard deviation varies between 20, 35 and 50. In the second run, the bimodal distribution consists of two normal distributions with means of -50 and +50. On the basis of the first results, parameters are reduced in the second analysis. Here, the standard deviation is constant 35.

¹³ Here, the number of iterations is fixed at 60. In the pretest of the model, this number enables different dynamics. Therefore, a missing polarization is not the result of the missing possibility of parties to move to extreme positions in the determined time. The problem of more iterations is the increasing computational time.
options. Within each iteration, parties choose their position in a random order. Because of the large number of iterations and repetitions, random errors should be compensated.

(4) Further, a function of party positioning is required. According to the theoretical concept parties are vote-maximizers with two exceptions: accountability and cooperation. But how do parties achieve this goal? Indeed, there is always a best choice for a party, but the assumption of perfect information is discussed in literature critically (e.g. Coughlin 1992: 21). Agent-based models of party competition generate several kinds of vote-maximizing strategies. One type is a function to find the global maximum of votes (Martin und Plümper 2004: 17). Here, the existence of perfect information is assumed. Additionally, these parties act proactive in the competition. A contrary type is the hunter strategy (Laver und Sergenti 2012: 28f.). Hunters randomly choose a position left or right to their own position. If they win votes, they continue to move in the same direction. If they lose votes, they just move to the opposite direction. In contrast to the first, this strategy is reactive and does not need any information about the voter distribution.

I implement both strategies in the model to test potential effects of the information level. Further, I realize a third strategy, which should strike a balance between both extreme types. The local maximizer has information about the voter distribution around his own position. In contrast to the hunter, he can step in the competition proactively, but he has not full information like the global maximizer.

I discussed two limitations of vote-maximization in Sartori’s typology. First, the accountability should prevent an extreme positioning of governing parties. Thus parties which are part of the coalition cannot occupy a position with a defined distance to the metric center. The distance can vary between 20 and 60 or 100. If the value of the parameter is 100, the model does not contain accountability of parties. Second, the possibility of cooperation prevents that all parties are lonely competitors. Because of the focus on a vote-seeking motivation, the formalization of cooperation refers to this factor. Therefore, cooperating parties does not only try to maximize their own votes. They also try to maximize the votes of the ‘alliance’. Two more functions are necessary to formalize the cooperation in a theoretical plausible way. The coalition has to remain ideologically connected and there is a defined maximal distance between the coalition parties. If both functions do not exist, the coalition

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14 Sartori (1976: 330) also discusses the concept of valence issues, but the ideological dimension can be interpreted in logic of position issues.
15 I label parties with this strategy ‘global maximizers’.
16 An additional parameter, which varies between 10 and 25, determines the information level of local maximizers.
17 The ideological consistency and affinity is often discussed as a condition for parties to form a coalition (e.g. Budge & Laver 1993: 501).
parties will use an implausible strategy: One coalition party positions to the left of the opposition parties and the other party positions to the right and then both parties move to the center. Furthermore, ideological consistent opposition parties can also cooperate by the terms.\(^{18}\)

(5) Because of the theoretical assumptions, I try to integrate both concepts in the model: the image- and the identification-voter. First, the concept of an image-voter is relatively easy to formalize. Here, voters choose the party with the lowest ideological distance.\(^{19}\) In contrast, the other concept is more difficult to formalize. The identification should be some kind of bonus for specific parties. In an extreme case this bonus would be too high for the voter to ever change his voting behavior. In another case, the voter may grant one or two parties a little bonus. But if there is an increase of the ideological differences between him and these parties, he will change his choice. For example, Plümper and Martin (2004: 12f.) try to formalize such a bonus. They choose a multiplicative weight. But there is a problem: Here, the absolute weighting increases with the distance. Thus, the identification bonus will be largest, if the voter is an extreme left-winger and the party is an extreme right-winger. But in Sartori’s argumentation the policy- and identification-concepts are connected. Because of this reason I use an alternative weight, which rewards ideological closeness and punishes a high distance.\(^{20}\)

Within this model three identification scenarios are possible: First, there is no party identification. Thus, all voters choose parties because of their ideological positions. Second, there is a uniform distribution of identification bonus. Before the first iteration is carried out, voters, which are placed in a defined range of a party, get a specified weight bonus for this party. Therefore, parties actually start in the middle of ‘their’ voter population. The defined range and bonus weight can vary, but they are identical for all parties in a repetition.\(^{21}\) Third, the center parties benefit from a systematic biased distribution. So the defined range and the bonus weight of these parties are higher in a repetition. The theoretical background of this scenario is Sartori’s argumentation of a centrifugal push because of the missing chance of some parties to win center (or moderate) votes (Sartori 1976: 344). As a result of these biased

\(^{18}\) For example, all opposition parties in six-party systems with wing coalitions cooperate. In contrast, only opposition party D and party E (see. Fig. 5) cooperate in six-party systems with a center coalition.

\(^{19}\) Distance = |Ideological Position of the Party – Ideological Position of the Voter|

\(^{20}\) The formula is: Weighted Distance = Distance – (Weight – Weight * Distance)^2 (for examples see appendix fig.11).

\(^{21}\) The weight and distance vary between 5 and 25.
voters the extreme parties only have a minor chance to profit of a moderate programmatic swing.\textsuperscript{22}

Two mechanisms of changing a voter’s position were discussed: In the model, the influence of parties on voters is realized as a slight chance in each iteration that a voter moves in the ideological direction of his favored party. Three parameters define (here formulated as questions) this mechanism: (1) Is there an endogenous preference formation? (2) How big is the chance to influence a voter?\textsuperscript{23} (3) Do extreme parties influence their voters with a greater impact? Further, dissatisfaction is the chance that a voter of a governing party moves in the direction of the nearest opposition party. This stimulus effects the situation before the first iteration takes place. One parameter defines the existence of dissatisfaction and the other parameter defines the percentage of dissatisfied voters.\textsuperscript{24}

(6) Lastly, the output has to be measured. In the theory the system dynamic represents the dependent variable. A centrifugal dynamic is interpreted as increasing polarization. In contrast, a decreasing polarization expresses a centripetal dynamic. The polarization is measured in each iteration. Therefore, I use Dalton’s index (2008: 906).\textsuperscript{25} Further, the dynamic is calculated as the average distance to the starting polarization:\textsuperscript{26}

\[
\text{System Dynamic} = \frac{\sum_{i=1}^{60} (P_0 - P_i)}{60}
\]

To integrate all described features 18 model parameters are needed (see appendix fig. 10). Because of the parameters’ ranges about 36.6 quintillion repetitions would be necessary to compute results of all possible input constellations.\textsuperscript{27} Therefore, the limitation of computational resources prevents a full parameterization like grid sweeping (Laver & Sergenti 2012: 57f.). An alternative solution is a random parameterization. But how can the general validity of an incomplete solved equation be estimated? The difference between the

\textsuperscript{22} The number of voters is 1000 in each repetition. In a pretest a varying number has no influence on the model. But a higher number of voters increases the calculation period rigorously. Therefore I decided to use a low number of voters.

\textsuperscript{23} This parameter varies between 1 and 5 percent. There is a chance to influence each iteration.

\textsuperscript{24} The percentage of dissatisfied voters varies between 10 and 65. Additionally, a third parameter limits the maximal distance between the voter and the party (variation: 25-75). If the distance is about the value, the voter will not orient on this opposition party. As a result a defined ideological compatibility is necessary to influence a voter.

\textsuperscript{25} Dalton’s Index: \textit{ization} = \sqrt{\frac{\sum (v_i \cdot \frac{P_i - \bar{P}}{r_{0.5}})^2}{\sum v_i}}; v = votes share, p = ideological position, r = range of the ideological dimension (in addition Franzmann 2008: 10f).

\textsuperscript{26} Two other ways of calculating the dynamic were tested in the pretest. First, the dynamic was calculated as a linear estimation, but the data showed a high heteroscedasticity between time (iterations) and polarization. As a result, the coefficients were biased, which cannot be interpreted. Second, the last value of polarization was subtracted from the first value. Hence, temporary shifts in the last iteration had a big influence on the solution. However, the involvement of all polarization values makes the most stable estimations possible.

\textsuperscript{27} This number can be calculated as product of all possible variation of all model parameters. Further, NetLogo also shows the necessary number of repetitions to calculate results of all possible model configurations.
number of theoretical possible constellations and actually computed constellations is huge. I argue that the parameterization can be interpreted in a statistical way. The whole ‘population’ covers all possible input constellations in the model and the random parameterization captures just a sample. In the social science many methods exist to estimate the validity of correlations in random samples. Thus, I will use test statistics and significance tests to check a general validity of correlations between input and output data. The number of cases is comparable to survey datasets, but the validity and reliability of the measured data is de facto perfect. This should be considered in the interpretation of the results.

After a descriptive overview and a one-way ANOVA, I use linear regression analysis. The dataset only includes input and output variables. Therefore, there is not any time-series or multilevel structure in the data. Further, the dependent variable is metric. Because of this complexity reduction, the use of OLS-estimation is possible. Beyond that the test of interaction effects is also possible. In addition, I use csQCA (e.g. Schneider & Wagemann 2012) to test sufficient and necessary condition

**Results of the first simulation run**

In the first analysis all repetitions have a unimodal voter distribution. Here, possible causes of centrifugal pushes are the focus point, but the descriptive overview (see fig. 6) clearly shows a centripetal tendency of the model. More than half of the repetitions have a positive average change – here, the polarization is decreased during the iterations. Both measures of central tendency are positive. A concentration around zero can also be observed. Hence, there is no significant change of polarization in many simulation runs. At a first glance centrifugal dynamics seem to be outliers. Probably, this is a result of the unimodal voter distribution. Although there are some examples of centrifugal pushes: In the case of the highest negative average change (-0.387), the polarization shifts from 0.312 to 0.649. Thus, there are relevant centrifugal pushes in the simulation.

---

28 Only about $4.93 \times 10^{-17}$ percent of the possible constellations are computed.
Nevertheless, the question is: Are there differences between repetitions with wing and center coalitions? Comparing the means, wing coalitions ($\bar{x}=0.07$) apparently has more repetitions with centripetal dynamics than center coalitions ($\bar{x}=0.03$). Furthermore, this difference is significant ($t$-test $p<.01$) and this kind of differences is in line with the theoretical assumptions. But the positive average of center coalitions is noticeable. Thus, competitions with center coalitions also produce centripetal patterns most of the time. In addition, the separated observation of the distribution also suggests that there are differences in the competition dynamic between the coalition types, but these differences should not be overestimated (see fig. 7). However, in competitions with center coalitions centrifugal pushes are also outliers:

Figure 7: Histogram of system dynamics separated by coalition types

Note: Relative frequency of system dynamics.

Regarding the theoretical argumentation, the impact of specific mechanisms on the macro-macro-correlation is discussed. Thus, these variables should effect the dynamic in different ways depending on the coalition type. Therefore, an analysis of variance and following a regression analysis are computed separately for subsamples (wing / center coalitions) and the entire sample.
In a one-way ANOVA, significant differences between the means can be observed in almost all cases (see tab. 1). Only means differentiated by accountability do not show relevant varieties in the (sub-) samples. Therefore, the accountability does not seem to explain the influence of wing coalition on a centripetal dynamic. In contrast, the means vary significantly regarding the cooperation parameter in all samples. ‘No cooperation’ always shows the lowest mean. Thus, a positive influence of cooperation is observed under center and wing coalitions. An effect depending on the coalition type cannot be verified at this point.

The results of dissatisfaction are in line with the predictions. Here, the mean in the subsample of wing coalitions is identical in both cases. Further, the mean is lower in iterations with center coalitions and a dissatisfied electorate. Hence, the effect of dissatisfaction seems to depend on the coalition type. The results of an endogenous preference formation are not coherent with the theoretical argumentation. Thus, iterations with an equal or biased distributed influence have a higher mean. Here, the competition dynamic is more centripetal and these differences are also significant in the sample with center coalitions.

<table>
<thead>
<tr>
<th>Table 1: One-way ANOVAs</th>
<th>wing coalition (mean)</th>
<th>center coalition (mean)</th>
<th>all (mean)</th>
<th>wing coalition (mean)</th>
<th>center coalition (mean)</th>
<th>all (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no cooperation</td>
<td>0.037</td>
<td>0.017</td>
<td>0.027</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>only opposition</td>
<td>0.099</td>
<td>0.054</td>
<td>0.077</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cooperates</td>
<td>0.069</td>
<td>0.021</td>
<td>0.044</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cooperation</td>
<td>0.080</td>
<td>0.041</td>
<td>0.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p&lt;.001</td>
<td>p&lt;.001</td>
<td>p&lt;.001</td>
<td>n. sig.</td>
<td>p&lt;.001</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td></td>
<td>no accountability</td>
<td>0.071</td>
<td>0.031</td>
<td>0.049</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>accountability</td>
<td>0.073</td>
<td>0.036</td>
<td>0.054</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n. sig.</td>
<td>n. sig.</td>
<td>n. sig.</td>
<td>n. sig.</td>
<td>n. sig.</td>
<td>n. sig.</td>
</tr>
</tbody>
</table>

In the next step, all variables are tested in a linear regression, so (statistical) effects of the input parameters can be specified. In addition to (unstandardized) regression coefficients, standard errors, significance levels and coefficients of determination I also report semi-partial correlation coefficients. Thus, a predictor’s unique proportion of explained variance can be estimated. First of all, the model fits vary considerably between the three models (see table 2). Model 1 has the highest determination coefficient. In the subsample of wing coalition, almost half of the variance can be explained. The (corrected) R² of both other models is distinctly lower.
**Table 2: Linear regression of system dynamics (first simulation run)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Models</th>
<th>Model 1 – Subsample wing coalitions</th>
<th>Model 2 – Subsample center coalitions</th>
<th>Model 3 – Entire sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.131** (0.011)</td>
<td>0.149** (0.011)</td>
<td>0.160** (0.008)</td>
<td></td>
</tr>
</tbody>
</table>

**Reference:** 4 parties

- **5 parties**
  - Reg. Coeff. B (S.E.): -0.001 (0.006)
  - Semi-Par.Corr.: -0.005 (0.006)

**Reference:** Global Maximizer

- Hunter: -0.165** (0.007)
  - Semi-Par.Corr.: -0.541 (0.008)

**Reference:** 20 Voter-SD

- 35 Voter-SD
  - Reg. Coeff. B (S.E.): 0.037** (0.006)
  - Semi-Par.Corr.: 0.143 (0.006)

**Reference:** no identity

- Uniform distributed identity
  - Reg. Coeff. B (S.E.): -0.030** (0.006)
  - Semi-Par.Corr.: -0.115 (0.006)

**Accountability**

- Reg. Coeff. B (S.E.): 0.002 (0.005)

**Endogenous Preference Formation**

- Reg. Coeff. B (S.E.): 0.019* (0.006)

**Biased Preference Formation**

- Reg. Coeff. B (S.E.): -0.010 (0.007)

**Dissatisfaction**

- Reg. Coeff. B (S.E.): 0.008 (0.005)

**Center Coalition**

- Reg. Coeff. B (S.E.): 0.494 (0.004)

Corrected r²: 0.494

n: 868

Significance Level: * p < 0.01; ** p < 0.001.

All predictors of the hunter variable are highly significant and show low standard errors. Also the semi-partial correlations of these predictors have the particular highest value. In reference to global maximizers, hunters have a negative influence on the system dynamic. Local maximizers have a weaker effect. Thus, a decreasing level of information seems to cause centrifugal patterns in party competition. This effect is plausible because of the unimodal voter distribution. Here, all attractive ideological positions to win votes are in a moderate area. But there are circumstances where hunters and local maximizers are not able
to find these ideological positions. Therefore, they compete for unattractive, non-moderate positions.

Regarding the number of parties, only six-party systems have a significant, negative effect referring to four-party systems in two of three models. On the contrary, the predictor of five-party systems is insignificant. Further, the standard deviation of the voter distribution has a significant influence on the dependent variable in two models. Their effects are also negative. Regarding a low standard deviation, a higher deviation causes a more centrifugal or a less centripetal dynamic. However, the remaining predictors are more interesting.

Both cooperation variables are significant in all models. Their effect is positive in subsamples with wing and center coalition, but the effect is greater in the wing coalition subsample. Here, the regressions coefficients and the semi-partial correlations are higher. Nevertheless, a clear validation of the first prediction is not possible. In contrast, the results of accountability are obvious. All predictors are insignificant and the semi-partial correlations are really low. Thus, this factor does not influence the dynamic in the formal model in a statistical relevant way. Prediction two can be falsified.

Also the predictors of endogenous preference formation are insignificant, but this observation was assumed. Further, a biased influence on voters has a negative effect in the sample of wing coalitions, which is significant. The assumption of prediction three is an interaction effect. In an additional regression model (see appendix Tab. 8) these effects does not show up. Hence, this prediction is also falsified. At least the results support prediction four: In the sample with center coalitions dissatisfaction shows a significant, negative effect with a noticeable semi-partial correlation. Such an effect is missing in model 1 with the wing coalitions.

There is a negative, significant effect of center coalitions in model 3. Thus, the type of coalition actually influences the competition dynamic in the formal model. Up to this point, cooperation and dissatisfaction remain the two possible explanations of this correlation. But I think the results are not undoubtedly clear. Next, I test specific configurations in csQCA to get an additional perspective.29 Because of the previous results and theoretical predictions, I concentrate on configuration of the cooperation and dissatisfaction parameters as well as the coalition type. Here, I mainly interpret the value of coverage and consistency. All configurations are tested as sufficient condition, but the coverage and consistency of the necessary condition can easily deduced from these results.30

29 Because of the method, the metric dependent variable has to be converted in truth values. Therefore, three thresholds are defined on the basis of the descriptive overview: ≤0 = (at least) minimal centrifugal dynamics, ≤-0.05 = (at least) low centrifugal dynamics, ≤-0.1 = (at least) average centrifugal dynamics and ≤-0.2 = (at least) high centrifugal dynamics.

30 The coverage of a sufficient condition is the consistency of a necessary condition of the same configuration. Exactly the other way around, the consistency of a sufficient condition is the coverage of a necessary condition of the same configuration (Schneider & Wagemann 2012: 119-147).
Table 3: Sufficient condition of the absence of centrifugal dynamics

<table>
<thead>
<tr>
<th>~minimal centrifugal dynamics</th>
<th>Absence of centrifugal dynamics</th>
<th>~ average centrifugal dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>~CE</td>
<td>C=1</td>
<td>C*O=1</td>
</tr>
<tr>
<td>868</td>
<td>1186</td>
<td>640</td>
</tr>
<tr>
<td>-CE<em>CC</em>CO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>220</td>
<td>1186</td>
<td>165</td>
</tr>
<tr>
<td>-CE*(CC+CO)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>666</td>
<td>1186</td>
<td>500</td>
</tr>
<tr>
<td>-CE*DS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>428</td>
<td>1186</td>
<td>327</td>
</tr>
<tr>
<td>-CE*(CC+CO)*DS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>329</td>
<td>1186</td>
<td>254</td>
</tr>
<tr>
<td>-CE*(CC+CO)+DS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>765</td>
<td>1186</td>
<td>573</td>
</tr>
</tbody>
</table>

Shortcuts: C = condition / O = outcome / ~ = logical negation / + = logical and / * = logical or / CE = center coalition / CC = cooperation of coalition / CO = cooperation of opposition / DS = Dissatisfaction.

Table 4: Sufficient condition of the presence of centrifugal dynamics

<table>
<thead>
<tr>
<th>minimal centrifugal dynamics</th>
<th>Presence of centrifugal dynamics</th>
<th>average centrifugal dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>C=1</td>
<td>C*O=1</td>
</tr>
<tr>
<td>936</td>
<td>618</td>
<td>390</td>
</tr>
<tr>
<td>CE*(CC+CO)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>707</td>
<td>618</td>
<td>277</td>
</tr>
<tr>
<td>CE<em>CC</em>CO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>220</td>
<td>618</td>
<td>74</td>
</tr>
<tr>
<td>CE*DS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>489</td>
<td>618</td>
<td>245</td>
</tr>
</tbody>
</table>

Shortcuts: C = condition / O = outcome / ~ = logical negation / + = logical and / * = logical or / CE = center coalition / CC = cooperation of coalition / CO = cooperation of opposition / DS = Dissatisfaction.
The general gap between the consistency values in table 3 and 4 stands out clearly. Wing coalition (~CE) is already a highly consistent sufficient condition of an absence of low and average centrifugal dynamics. Also the coverage shows values around 0.5. Further, an addition of more conditions to the configuration cannot crucially increase the consistency. In contrast, center coalition (CE) is not a persuasive sufficient condition of centrifugal dynamics. Here, the consistency achieves values of maximal 0.51. On the other hand center coalition is a moderate consistent necessary condition. Here, values above 0.7 are reached by low and average centrifugal dynamics. However, the coverage of these conditions is really low.

In the first analysis with unimodal distributions, the assumption of centrifugal pushes of center coalition should be tested, but centripetal dynamics outweigh. Only some outliers show stronger centrifugal dynamics. However, dissatisfaction and cooperation provide possible explanations of different dynamics depending on the coalition type in the regression analysis and the ANOVA. These variables have different effects in the subsamples. Surely, the effect of cooperation is also positive in the sample of center coalitions, but the coefficient and the semi-partial correlation are weaker. However, I think that these parameters can only explain the absence of centripetal drives and not the presence of centrifugal pushes. Regarding the research question, this kind of explanation is unsatisfactory because the model does not provide a theoretical explanation of a relevant increasing polarization of party systems.

However, the results of the csQCA provide another possible answer. On the one hand the presence of center coalitions is not a satisfying explanation of (extreme) centrifugal pushes, on the other hand the presence of wing coalitions seems to be an adequate explanation of the absence of centrifugal pushes. Therefore the focus point should be shifted from center coalitions to wing coalitions. The problem is that the unimodal voter distribution seems to determine centripetal precondition of the competition. But if the precondition usually causes a centripetal drives, the wing coalitions will not show considerably effects. Thus, I simulate a bimodal voter distribution to create centrifugal preconditions in the model.
Results of the second simulation run

In the second analysis, the number of parameters is reduced to obtain a simpler model, which is focused on the central theoretical argument. Therefore, parameters of falsified predictions are dropped out: Thus, endogenous preference formation and accountability is missing in this analysis. Further, the different party heuristics had a great impact on the dynamics in the first analysis. To reduce this theoretically uninteresting variance, all parties in all iterations are local maximizers. This should be the best compromise.

Two explanatory parameters remain: dissatisfaction and cooperation. Because of the modified causal explanation dissatisfaction (and prediction four) provides no longer a theoretical explanation. In the argumentation dissatisfaction is supposed to be a cause of centrifugal pushes, but there are already centrifugal preconditions in the second simulation run as a result of the bimodal distribution. Further, cooperation can be identified as a centripetal factor in the first analysis. In the theoretical argumentation, different effects of cooperation are assumed depending on the coalition type. If there is a wing coalition, the contested voter population will change because of the cooperation mechanism:

Figure 8: Different focus points

If the coalition parties A and B and the opposition parties C, D and E are all selfish vote-maximizers, the interesting voter population will be around point P1 and P2. Here, the density of voters is highest. Therefore, centrifugal competition patterns occur, but a cooperation of parties of both groups shifts the focus to point P3. Although there are only a few voters in the ideological center, these are the relevant swing voters. A comparable mechanism is not supposed in a party system with a center coalition. Because of these theoretical assumptions, the cooperation parameters remain part of the model.
Regarding the first results, a descriptive overview shows different patterns of competition dynamics in the second run:

**Figure 9: Boxplots of competition dynamics**

First, the dynamic varies differently in the six subsamples. Wing and center coalitions show distinct varieties of variance patterns with one exception: In the subsamples with no cooperation there is no significant difference between the coalition types. The most interesting subsample is the third case of wing coalition. Here, coalition and opposition parties cooperate and no centrifugal patterns are showed. On the contrary, there are centrifugal dynamics in all subsamples with center coalition. Nevertheless, cooperation seems to influence the system dynamic in a centripetal way, even in systems with center coalition. Further, the entire sample shows a negative mean (-0.02) and median (-0.05). The precondition of the competition changes in the second run.

Next, I will test the influence of the single model parameters on the output in a linear regression. Afterwards, these results will be complemented by a csQCA:
Table 5: Linear regression of system dynamics (second simulation run)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Models</th>
<th>Model 1 – Subsample wing coalitions</th>
<th>Model 2 – Subsample center coalitions</th>
<th>Model 3 – Entire sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>(constant)</td>
<td></td>
<td>-0.098** (0.011)</td>
<td>-0.118** (0.01)</td>
<td>-0.033** (0.009)</td>
</tr>
<tr>
<td>Reference: 4 parties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 parties</td>
<td></td>
<td>-0.027* (0.010) -0.057</td>
<td>0.001 (0.010) 0.003</td>
<td>-0.018 (0.007) -0.039</td>
</tr>
<tr>
<td>6 parties</td>
<td></td>
<td>-0.009 (0.010) -0.020</td>
<td>0.017 (0.009) 0.051</td>
<td>0.003 (0.007) 0.007</td>
</tr>
<tr>
<td>Reference: no identity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uniform distributed identity</td>
<td></td>
<td>-0.089** (0.010) -0.187</td>
<td>-0.086** (0.010) -0.249</td>
<td>-0.086** (0.007) -0.192</td>
</tr>
<tr>
<td>biased distributed identity</td>
<td></td>
<td>-0.076** (0.010) -0.158</td>
<td>-0.141** (0.010) -0.412</td>
<td>-0.109** (0.007) -0.241</td>
</tr>
<tr>
<td>cooperation (coalition)</td>
<td></td>
<td>0.211** (0.008) 0.545</td>
<td>0.108** (0.008) 0.383</td>
<td>0.158** (0.006) 0.431</td>
</tr>
<tr>
<td>cooperation (opposition)</td>
<td></td>
<td>0.233** (0.008) 0.601</td>
<td>0.090** (0.008) 0.320</td>
<td>0.161** (0.006) 0.439</td>
</tr>
<tr>
<td>Corrected r²</td>
<td></td>
<td>0.705</td>
<td>0.437</td>
<td>0.604</td>
</tr>
<tr>
<td>n</td>
<td></td>
<td>731</td>
<td>738</td>
<td>1469</td>
</tr>
</tbody>
</table>

Significance Level: *p < 0.01; ** p < 0.001.

The suppositions of the descriptive statistic are also shown in these results. Both cooperation parameters have a positive, significant effect and the semi-partial correlations of these variables have remarkable values in all models. Hence, effects of these parameters are in line with the theoretical assumptions and cooperation explains (statistically) a crucial part of the system dynamic: Cooperation clearly causes centripetal patterns in the formal model, although the extent of these effects varies in the subsamples. In repetitions with wing coalition, the regressions coefficients and the semi-partial correlations are considerably higher. Further, predictors of both interaction effects (cooperation parameters * coalition type) are significant and the determination coefficients increase by around two and four percentage points (see appendix Tab. 7). Therefore, the centripetal effect of cooperation depends on the coalition type in the regressions analysis. Lastly, I test two different configurations of wing coalitions and cooperation:
The cooperation of coalition and opposition parties in addition with a wing coalition is a consistent sufficient condition (~CE*CC*CO) of the absence of centrifugal dynamics. Further, the coverage values indicate a relevance of the configuration. In addition, the other configuration (~CE*(CC+CO)) shows remarkable consistency values, too. But the deterministic absence of centrifugal drives is only achieved by the cooperation of both groups. After a second simulation run the central result is: The prevention of centrifugal dynamics by wing coalitions can be explained by the mechanism of cooperation in the theoretical model.

**Conclusion**

Satori discusses centrifugal pushes of center coalition in his theoretical argumentation in detail. Regarding competition dynamics a negative evaluation of center parties is common in political science literature (e.g. Hazan 1997, Green-Pedersen 2004, Keman 1994, Johnston 2008, Pelizzo & Babones 2007). But the results of the formal model do not support this conclusion. In the first simulation run with a unimodal voter distribution, there were only centrifugal pushes to a limited extent. Indeed, some repetitions provide weak centrifugal patterns, but only some outliers show relevant polarizations of the party system. Hence, an occupied center may prevent a competition for the median voter, but the focus shifts only on moderate voter populations and not on ideological extreme positions. Thus, the microfoundation of center coalitions pushes does not work in the formal model. Nevertheless, the results show an alternative causal chain which is possible in the logic of Sartori’s typology.
In party systems with wing coalitions, centrifugal pushes are prevented, because of the cooperation of coalition and (ideological consistent) opposition parties. Therefore, even party systems with centrifugal preconditions do not show any centrifugal patterns. This conclusion has a great impact on the theoretical argumentation and empirical analysis. Center coalition is only a necessary but not a sufficient condition of an increasing polarization in the theoretical concept: center coalition does not initiate centrifugal dynamics. Therefore, this coalition type could also occur in party systems of moderate pluralism.

Indeed, such a kind of an adjustment of Sartori’s typology already exists. Von Beyme (2000: 160) added cases of center coalitions to the type of moderate pluralism, but until now a theoretical reasoning was missing. Furthermore, these adjustments are especially interesting, because the author argues with an empirical necessity. Thus, von Beyme finds party systems with center coalitions and patterns of moderate pluralism. Surely, this supports the conclusion of the model.

But the results have also another implication: A test of theoretical predictions in agent-based models and a microfoundation of macro-level correlation are not an end in itself. The results provide essential informations about the theoretical concept. Therefore, the logical consistency of the theory can be ensured. Also, agent-based simulations make possible to model a variety of theoretical assumptions. Therefore, theories, which cannot be formalized in analytical models, can be formalized in this approach.

Nevertheless, an important step of the research process surely misses. An empirical testing still lacks. The agent-based simulation may improve the understanding of theoretical causalities and test the logical validity of predictions, but it remains a theoretical model. Thus, the next step should be deducing hypothesis on the basis of the model and an empirical test. Because the range and validity of the theoretical concept cannot be estimated, up to this point. Obviously, the deduced hypothesis would be: A center coalition in party competition is a necessary condition of an increasing polarization.

References


Ware, A. (1996) *Political parties and party systems*. Oxford [i.a.]: Oxford University Press.
### Appendix

#### Figure 10: Variables and parameters

<table>
<thead>
<tr>
<th>model parameter (variation)</th>
<th>computed variables</th>
</tr>
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<tbody>
<tr>
<td>Competition scenario (0-5)</td>
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</tr>
<tr>
<td></td>
<td>4 parties: 1 if parameter = 0 oder 1; else 0</td>
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<tr>
<td></td>
<td>5 parties: 1 if parameter = 2 oder 3; else 0</td>
</tr>
<tr>
<td></td>
<td>6 parties: 1 if parameter = 4 oder 5; else 0</td>
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<tr>
<td></td>
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<tr>
<td>Distance between parties (15-35)</td>
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<tr>
<td>Party strategy (0-2)</td>
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<tr>
<td></td>
<td>Hunter: 1 if parameter = 2; else 0</td>
</tr>
<tr>
<td></td>
<td>Local Maximizer: 1 if parameter = 1; else 0</td>
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<tr>
<td></td>
<td>Global Maximizer: 1 if parameter = 0; else 0</td>
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<tr>
<td>Local radius (10-25)</td>
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<td>Cooperation (Coalition): Identical</td>
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<td>Cooperation (Opposition) (0-1)</td>
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<tr>
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<td>Identification weight (5-25; 0)</td>
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Figure 11: Identification weight

Table 7: OLS-regression of system dynamics (interaction effects in the second simulation run)

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Significance Level: * p < 0.01; ** p < 0.001.
Table 8: OLS-regression of system dynamics (interaction effects in the first simulation run)

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</table>

Significance Level: * p < 0.01; ** p < 0.001.
Figure 12: NetLogo source code

globals [  
  coalition-votes coalition-votes-old unit-opposition-votes unit-opposition-votes-old party-list polarization extremisation start-polarization start-extremisation last-polarization last-extremisation polarization-list polarization-average-distance  
]

m-party-1-votes m-party-2-votes m-party-3-votes m-party-4-votes m-party-5-votes m-party-6-votes m-party-1-xcor m-party-2-xcor m-party-3-xcor m-party-4-xcor m-party-5-xcor m-party-6-xcor coalition-list party-1-votes party-2-votes party-3-votes party-4-votes party-5-votes party-6-votes party-1-xcor party-2-xcor party-3-xcor party-4-xcor party-5-xcor party-6-xcor]

breed [voters voter]  
breed [parties party]

parties-own [ votes-total last-votes-total hunt-xcor coalition unite-opposition ]

voters-own [ elected-party party-identification satisfaction ]

to setup
  clear-all
  ask patches [ set pcolor white ]
  list-setup
  if use? = "Model Unimodal" [ model-unimodal-setup ]
  if use? = "Model Bimodal" [ model-bimodal-setup ]

  calculate-election-result
  set coalition-votes-old coalition-votes
  set coalition-votes-old coalition-votes
  ask parties [ set last-votes-total votes-total ]
  set max-ticks 61
  reset-ticks
  measure-polarization
  measure-extremisation
  set start-polarization polarization
  set start-extremisation extremisation
  collect-party-data
  if use? = "User" [ show-elected-parties show-identification ]

end

to go
  if use? = "User" [ show-elected-parties show-identification ]
  if ticks = 1 and dissatisfaction-stimulus = 1 [  
    dissatisfaction
    voter-movement
    ]
  if ticks > 1 [  
    move-parties
    calculate-election-result
    collect-party-data
    if believers = 1 [ believer-move ]
    ]
  measure-polarization
  measure-extremisation
  save-measurement-lists

  if ticks = max-ticks [  
    set polarization-average-distance average-distance-to-start polarization-list
    set extremisation-average-distance average-distance-to-start extremisation-list
    set last-polarization polarization
    set last-extremisation extremisation
    stop
  ]
  tick

end

to create-voters-ini-normal
  set number-of-voters ( random 1500 ) + 1200
  create-voters number-of-voters [  
    let x -200
    while [ x < -100 or x > 100 ][
      set x precision ( random-normal 0 voter-sd ) 0 ]
      setxy x 0

  ]

end

to voter-distribution [#sd #n]
  let filename ( word "Data-SD" #sd ".txt")
  let voter-list textfile filename 201
  let i -100
  repeat 201 [  
    if item ( i + 100 ) voter-list > 0 [ create-voters item ( i + 100 ) voter-list [ setxy i 0 ]]
    set i i + 1

  ]
  set voter-sd #sd

end
A Microfoundation of Centrifugal Dynamics in Party Systems

Johannes Schmitt

**to create-parties-s1a**

```plaintext
let x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x - party-distance / 2  
  set xy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
set party-list lput -999 party-list
set x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x + party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
set party-list lput -999 party-list
end
```

**to create-parties-s1b**

```plaintext
let x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x - party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x - party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x - party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
set party-list lput -999 party-list
set x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x + party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
set party-list lput -999 party-list
end
```

**to create-parties-s2a**

```plaintext
let x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x - party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
set party-list lput -999 party-list
set x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x - party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x - party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
set party-list lput -999 party-list
end
```

**to create-parties-s2b**

```plaintext
let x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x - party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
set party-list lput -999 party-list
set x 0
create-parties 1 [  
  set coalition 1  
  set unit-opposition 0  
  set x x - party-distance / 2  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x - party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
create-parties 1 [  
  set coalition 0  
  set unit-opposition 0  
  set x x + party-distance  
  setxy x 0  
  set party-list lput who-party-list  
]
end
```
to create-parties-s1c
let x 0
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance / 2 setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 0 set unit-opposition 0 set x x + party-distance / 2 setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 0 set unit-opposition 1 set x x + party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 0 set unit-opposition 1 set x x + party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 0 set unit-opposition 1 set x x + party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 0 set unit-opposition 1 set x x + party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 0 set unit-opposition 1 set x x + party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 0 set unit-opposition 1 set x x + party-distance setxy x 0 set party-list lput who party-list ]
end
to create-parties-s2c
let x 0
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance / 2 setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
create-parties 1 [ set coalition 1 set unit-opposition 0 set x x - party-distance setxy x 0 set party-list lput who party-list ]
end
to party-identification-setup-1-nothing
ask voters [repeat 6 [set party-identification lput 0 party-identification]]
end
to party-identification-setup-2-equal
let xlist parties-xcor-list
ask voters [ let i 0 repeat 6 [ ifelse item i party-list ! 0.999 [ ifelse xcor <= ((item i xlist) + identity-space) and xcor >= ((item i xlist) - identity-space) [set party-identification lput [identification-bias * 1.1] party-identification] [set party-identification lput 0 party-identification] set i i + 1 ] ]]
end
to party-identification-setup-3-strong-middle
let xlist parties-xcor-list
ask voters [ let i 0 repeat 6 [ ifelse item i party-list != 0.999 [ ifelse i = 0 or i = 3 [ifelse xcor <= ((item i xlist) + (identity-space * 2)) and xcor >= ((item i xlist) - (identity-space * 2)) [set party-identification lput (identification-bias * 1.1) party-identification] [set party-identification lput 0 party-identification] [ifelse xcor <= ((item i xlist) + identity-space) and xcor >= ((item i xlist) - identity-space) [set party-identification lput identification-bias party-identification] [set party-identification lput 0 party-identification] ] ] ] ]
end
to-report parties-xcor-list
let plist (list)
let i 0
repeat 6 [ ifelse item i party-list != -999 [ask party item i party-list [set plist lput xcor plist]] [set plist lput -999 plist]
set i i + 1 ]
report plist
end
to show-identification
let i 0
repeat 6 [ ask voters with [item i party-identification != 0] [let x xcor ask patch x (-4 - i) [set pcolor item (item i party-list) party-color-list]]
set i i + 1 ]
end
to voter-movement
no-display
ask voters with [satisfaction = 0] [let b false
let new-x 1000
let x -999
ask turtle min-distance-opposition [set x xcor]
if x < xcor [ while [b = false]
set new-x precision (random-normal 0 20) 0
ifelse (x + new-x) >= -100 and (x + new-x) <= 100 and abs(new-x) <= 20 [set b true] [set b false]
] if abs(xcor - x) <= maximal-move-distance [set xcor x + new-x]
] if x > xcor [ while [b = false]
set new-x precision (random-normal 0 20) 1
ifelse (x - new-x) >= -100 and (x - new-x) <= 100 and abs(new-x) <= 20 [set b true] [set b false]
] if abs(xcor - x) <= maximal-move-distance [set xcor x - new-x]
]
display
end
to dissatisfaction
let i 1
ask voters with [elected-party != -999] [let bool 0
ask elected-party [set bool coalition]
if bool = 1 [ if i <= dissatisfaction-factor [set satisfaction 0] ifelse i != 100 [set i i + 1] [set i 1]
]
end
to believer-move
ask voters with [elected-party != -999] [let x 0
ask elected-party [set x xcor]
let chance believer-chance
if believer-true = 1 [set chance chance * (((abs(x) / 100) * 3) + 1)]
set chance 100 - chance
if random 101 >= chance [ let move-dis 999
while [xcor - move-dis < -100 or xcor + move-dis > 100]
set move-dis abs[precision (random-normal 20 5) 0]
] ifelse xcor < x [set xcor xcor + move-dis] [set xcor xcor - move-dis]
]
end
to global-perfect-move
  no-display
  let voters-maximum votes-total
  let max-xcor xcor
  let coalition-dis calc-distance-coalition
  let opposition-dis calc-distance-opposition
  if opposition-cooperation = 1 and unit-opposition = 1 [ set voters-maximum unit-opposition-votes ]
  if coalition = 1 and coalition-cooperation = 1 [ voters-maximum coalition-votes ]
  let i = 100
  repeat 201 [
    i 
    if i >= -100 and i <= 100 [ set xcor i ]
    calculate-election-result
set xcor max-xcor
calculate-election-result
display
end

to local-perfect-move
  no-display
  let voters-maximum votes-total
  let max-xcor xcor
  let coalition-dis calc-distance-coalition
  let opposition-dis calc-distance-opposition
  if opposition-cooperation = 1 and unit-opposition = 1 [ set voters-maximum unit-opposition-votes ]
  if coalition = 1 and coalition-cooperation = 1 [ set voters-maximum coalition-votes ]
  let i xcor = localradius
  repeat ((localradius * 2) + 1) [
    i 
    if i >= -100 and i <= 100 [ set xcor i ]
    calculate-election-result
    if coalition = 1 [ if coalition-cooperation = 1 [ ifelse connected-coalition = true and coalition-votes > voters-maximum and calc-distance-coalition <= max-coop-distance and abs(xcor) <= max-coalition-position [ set voters-maximum coalition-votes set max-xcor xcor set coalition-dis calc-distance-coalition ] [ if connected-coalition = true and coalition-votes >= max-voters-maximum and coalition-dis > calc-distance-coalition and (abs(xcor) <= max-coalition-position or abs(xcor) < abs(max-xcor)) [ set voters-maximum coalition-votes set max-xcor xcor set coalition-dis calc-distance-coalition ] ] ] ] if coalition-cooperation = 0 [
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if else votes-total > voters-maximum and abs(xcor) <= max-coalition-position [set voters-maximum votes-total set max-xcor xcor]
    [ if else votes-total = voters-maximum and abs(xcor) < abs(max-xcor) and abs(xcor) > max-coalition-position [set voters-maximum votes-total set max-xcor xcor] if votes-total = voters-maximum and random 2 = 1 [set voters-maximum votes-total set max-xcor xcor] ]
}
if coalition = 0 [
    if opposition-cooperation = 1 and unit-opposition = 1 [
    ]
if coalition = 0 and opposition = 0 [ set i i + 1 ]
    set xcor max-xcor calculate-election-result display
end
to hunter
    let x xcor
    let coalition-dis calc-distance-coalition
    let opposition-dis calc-distance-opposition
    no-display
    if coalition = 1 and coalition-cooperation = 1 [
        if coalition-votes < coalition-votes-old [set hunt-xcor hunt-xcor * -1] if coalition-votes = coalition-votes-old and random 2 = 1 [set hunt-xcor hunt-xcor * -1] if (xcor + hunt-xcor) <= 100 and (xcor + hunt-xcor) >= -100 [ set xcor xcor + hunt-xcor if else (abs(xcor) > max-coalition-position and abs(xcor) > abs(hunt-xcor)) [set xcor xcor - hunt-xcor set hunt-xcor hunt-xcor * -1] if connected-coalition = false or (calc-distance-coalition > max-coop-distance and abs(xcor - coalition-average) > abs(hunt-xcor - hunt-xcor - coalition-average)) [set xcor xcor - hunt-xcor set hunt-xcor hunt-xcor * -1]]
    ]
    if coalition = 1 and coalition-cooperation = 0 [
        if votes-total < last-votes-total [set hunt-xcor hunt-xcor * -1] if votes-total = last-votes-total and random 2 = 1 [set hunt-xcor hunt-xcor * -1] if (xcor + hunt-xcor) <= 100 and (xcor + hunt-xcor) >= -100 [ set xcor xcor + hunt-xcor if (abs(xcor) > max-coalition-position and abs(xcor) > abs(x)) [set xcor xcor - hunt-xcor set hunt-xcor hunt-xcor * -1]]
    ]
    if coalition = 0 and opposition-cooperation = 1 and unit-opposition = 1 [
    ]
    if coalition = 0 and (opposition-cooperation = 0 or unit-opposition = 0) [
        if votes-total < last-votes-total [set hunt-xcor hunt-xcor * -1] if votes-total = last-votes-total and random 2 = 1 [set hunt-xcor hunt-xcor * -1] if (xcor + hunt-xcor) <= 100 and (xcor + hunt-xcor) >= -100 [ set xcor xcor + hunt-xcor ]
    ]
    display calculate-election-result
end
to move-parties
    if party-heuristic = 0 [ask parties [global-perfect-move]] if party-heuristic = 1 [ask parties [local-perfect-move]] if party-heuristic = 2 [ask parties [hunter]]
to measure-polarization
  let x 0
  let i 0
  ask parties [set i i + 1
    set x x + xcor
  ]
  let party-average-xcor x / i
  let xs 0
  ask parties [set xs xs + (((votes-total / (count voters with [elected-party != -999])) * (((xcor - party-average-xcor) / 100.5) ^ 2))]
  set polarization sqrt (xs)
end

to measure-extremisation
  let xs 0
  ask parties [set xs xs + (((votes-total / (count voters with [elected-party != -999])) * (((xcor - 0) / 100.5) ^ 2))]
  set extremisation sqrt (xs)
end

to save-measurement-lists
  set polarization-list lput polarization polarization-list
  set extremisation-list lput extremisation extremisation-list
end

to count-coalition-votes
  let count-votes 0
  ask parties with [coalition = 1] [set count-votes count-votes + votes-total]
  set coalition-votes count-votes
end
to count-united-opposition-votes
  let count-votes 0
  ask parties with [unit-opposition = 1][set count-votes count-votes + votes-total]
  set unit-opposition-votes count-votes
end
to calculate-election-result
  ask voters [set elected-party min-distance-party]
  ask parties [set last-votes-total votes-total
    set votes-total count voters with [elected-party = myself]
  ]
  set coalition-votes-old coalition-votes
  set unit-opposition-votes-old unit-opposition-votes
  count-united-opposition-votes
  count-coalition-votes
end
to report min-distance-party
  let i 1
  let min-distance weight-distance distance turtle item 0 party-list item 0 party-identification
  let min-party item 0 party-list
  repeat 5 [if item i party-list != -999 [print i
    let min-i weight-distance distance turtle item i party-list item i party-identification
    ifelse min-i < min-distance [set min-distance min-i
      set min-party item i party-list
    ]
    if min-i = min-distance and random 2 = 1 [set min-distance min-i
      set min-party item i party-list
    ]
    ]
    set i i + 1]
  ifelse min-distance <= max-vote-dis [report turtle min-party][report -999]
end
to-report min-distance-opposition
  let i 0
  let min-party -999
  let min-distance 999
  repeat 6 [  
    if item i party-list != -999 and (i + 1) <= count parties [  
      if coalition-status i = 0 [  
        let min-distance-999
        repeat 6 [  
          if item i party-list item i party-identification
          if min-distance i weight-distance turtle item i party-list
          if min-distance i < min-distance [set min-party item i party-list]
        ]  
        set i i + 1  
      ]  
      report min-party
    end
  ]
end

to-report coalition-status [#party]
  let b -999
  ask turtle item #party party-list [set b coalition]
  report b
end

to collect-party-data
  let n count voters with [elected-party != -999]
  ask turtle 0 [  
    set m-party-1-xcor lput xcor m-party-1-xcor
    set m-party-1-votes lput (votes-total / n) m-party-1-votes
  ]
  ask turtle 1 [  
    set m-party-2-xcor lput xcor m-party-2-xcor
    set m-party-2-votes lput (votes-total / n) m-party-2-votes
  ]
  ask turtle 2 [  
    set m-party-3-xcor lput xcor m-party-3-xcor
    set m-party-3-votes lput (votes-total / n) m-party-3-votes
  ]
  ask turtle 3 [  
    set m-party-4-xcor lput xcor m-party-4-xcor
    set m-party-4-votes lput (votes-total / n) m-party-4-votes
  ]
  if count parties > 4 [  
    ask turtle 4 [  
      set m-party-5-xcor lput xcor m-party-5-xcor
      set m-party-5-votes lput (votes-total / n) m-party-5-votes
    ]
  ]
  if count parties > 5 [  
    ask turtle 5 [  
      set m-party-6-xcor lput xcor m-party-6-xcor
      set m-party-6-votes lput (votes-total / n) m-party-6-votes
    ]
  ]
end

to-report average-distance-to-start [#liste]
  let liste (list)
  let a 0
  let i 2
  set liste #liste
  let ref item 1 liste
  repeat (max-ticks - 1) [  
    set a a + (ref item i liste)
    set i i + 1  
  ]
  set a a / (max-ticks - 2)
  report precision a 8
end

to model-unimodal-setup
  let scen random 6
  if scen = 0 [set scenario-typ 0]
  if scen = 1 [set scenario-typ 1]
  if scen = 2 [set scenario-typ 2]
  if scen = 3 [set scenario-typ 3]
  if scen = 4 [set scenario-typ 4]
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if scen = 5 [set scenario = 5]\nset coalition-cooperation random 2\nset opposition-cooperation random 2\nifelse coalition-cooperation = 1 [set max-coop-distance (random 41) + 20][set max-coop-distance 201]\nifelse random 2 = 1 [set max-coalition-position (random 46) + 25 ][set max-coalition-position 100]\nsat dissatisfaction-stimulus random 2\nifelse dissatisfaction-stimulus = 1 [set dissatisfaction-factor (random 56) + 10][set dissatisfaction-factor 0]\nifelse dissatisfaction-stimulus = 1 [set maximal-move-distance (random 51) + 25][set maximal-move-distance 0]\nsat party-distance (random 21) + 15\nsat believers random 2\nifelse believers = 1 [set believer-chance (random 5) + 1][set believer-chance 0]\nifelse believers = 1 [set believer-true random 2][set believer-true 0]\nifelse random 6 = 1 [set party-heuristic 0][ifelse random 2 = 1 [set party-heuristic 1][set party-heuristic 2]]\nset localradius (random 16) + 10\nifelse random 3 = 1 [set identification-mode 0][ifelse random 2 = 1 [set identification-mode 1][set identification-mode 2]]\nif identification-mode = 0 [set identification-bias (random 20) + 5]\nif identification-mode = 0 [set identification-space (random 20) + 5]\nset max-vote-dis 201\nparty-setup\nlet sd 0\nifelse random 3 = 1 [set sd 20][ifelse random 2 = 1[set sd 35][set sd 50]]\nlet voters-n 0\nsat voters-n 1000\nsat distribution sd voters-n\nsat voter-setup\nend

to model-bimodal-setup
let scen random 6\nif scen = 0 [set scenario = 0]\nif scen = 1 [set scenario = 1]\nif scen = 2 [set scenario = 2]\nif scen = 3 [set scenario = 3]\nif scen = 4 [set scenario = 4]\nif scen = 5 [set scenario = 5]\nset coalition-cooperation random 2\nset opposition-cooperation random 2\n;elseif coalition-cooperation = 1 [set max-coop-distance (random 41) + 20][set max-coop-distance 201]\nset max-coop-distance 201\n;elseif random 2 = 1 [set max-coalition-position (random 46) + 25 ][set max-coalition-position 100]\nset max-coalition-position 100\nsat dissatisfaction-stimulus 0\nsat dissatisfaction-factor 0\nsat maximal-move-distance 0\nsat party-distance (random 11) + 15\nsat believers random 2\nifelse believers = 1 [set believer-chance (random 5) + 1][set believer-chance 0]\n;elseif believers = 1 [set believer-true random 2][set believer-true 0]\nset believer-true 0\n;elseif random 6 = 1 [set party-heuristic 0][ifelse random 2 = 1 [set party-heuristic 1][set party-heuristic 2]]\nset party-heuristic 1\nset localradius (random 16) + 10\nifelse random 3 = 1 [set identification-mode 0][ifelse random 2 = 1 [set identification-mode 1][set identification-mode 2]]\nif identification-mode = 0 [set identification-bias (random 20) + 5]\nif identification-mode = 0 [set identification-space (random 20) + 5]\nset max-vote-dis 201\nparty-setup\nlet sd 0\nifelse random 3 = 1 [set sd 20][ifelse random 2 = 1[set sd 35][set sd 50]]\nlet filename (word "bimodal-1000.txt")\nlet voter-list (textfile filename 201\nlet i -100\nrepeat 201 [\nif item (i + 100) voter-list > 0 [create-voters item (i + 100) voter-list [setxy i 0]]\nset i i + 1\n]\nset voter-sd 999\npri voter-setup\nend

to party-setup
set party-color-list [red blue green yellow brown violet];Maximal 6 unterschiedliche Farben für die Parteien (als Liste gespeichert)\nsat-default-shape parties "triangle 2"\nif scenario-typ = 0 [create-parties-s1a]\nif scenario-typ = 1 [create-parties-s1b]\nif scenario-typ = 2 [create-parties-s1c]\nif scenario-typ = 3 [create-parties-s2a]
if scenario-typ = 4 [create-parties-s2b]
if scenario-typ = 5 [create-parties-s2c]
ask parties [set size 6
set color item who party-color-list
if coalition = 1 [ifelse coalition-cooperation = 1 [set shape "circle"] [set shape "circle 2"]]
if unit-opposition = 1 and opposition-cooperation = 1 [set shape "triangle"]
]
ask parties [ifelse random 2 = 1 [set hunt-xcor 1] [set hunt-xcor -1]]
let i 0
repeat 6 [ifelse item i party-list != -999 [ask party item i party-list [set coalition-list lput coalition-list coalition-list]]
[set coalition-list lput -999 coalition-list]
set i i + 1]
end
to voter-setup
ask voters [set color black
set shape "person"
set party-identification (list)]
ask voters [set satisfaction 1]
if identification-mode = 0 [party-identification-setup-1-nothing]
if identification-mode = 1 [party-identification-setup-2-equal]
if identification-mode = 2 [party-identification-setup-3-strong-middle]
end
to list-setup
set polarization-list (list)
set extremisation-list (list)
set party-list (list)
set m-party-1-votes (list)
set m-party-2-votes (list)
set m-party-3-votes (list)
set m-party-4-votes (list)
set m-party-5-votes (list)
set m-party-6-votes (list)
set m-party-1-xcor (list)
set m-party-2-xcor (list)
set m-party-3-xcor (list)
set m-party-4-xcor (list)
set m-party-5-xcor (list)
set m-party-6-xcor (list)
set coalition-list (list)
end
To-report textfile [#filename #rows]
File-open #filename
Let results n-values #rows
[file-read]
File-close
Report results
end
To-report calc-distance-opposition
let min-x 101
let max-x -101
ask parties with [unit-opposition = 1][
if xcor > max-x [set max-x xcor]
if xcor < min-x [set min-x xcor]
]
Report max-x - min-x
End
To-report united-opposition-average
let i 0
ask parties with [unit-opposition = 1][
set i i + 1
set avg avg + xcor
]
Report avg / i
end
To-report weight-distance [#distance #weight]
   Report #distance - ((#weight - #weight * (#distance / 200)) ^ 2)
End

To-report calc-distance-coalition
let min-x 101
let max-x -101
ask parties with [coalition = 1][
   if xcor > max-x [set max-x xcor]
   if xcor < min-x [set min-x xcor]
]
Report max-x - min-x
End

To-report connected-coalition
let cmin-x 101
let cmax-x -101
let bool true
ask parties with [coalition = 1][
   if xcor > cmax-x [set cmax-x xcor]
   if xcor < cmin-x [set cmin-x xcor]
]
ask parties with [coalition = 0][
   if xcor <= cmax-x and xcor > cmin-x [set bool false]
]
Report bool
End

To-report connected-unit-opposition
let omin-x 101
let omax-x -101
let bool true
ask parties with [unit-opposition = 1][
   if xcor > omax-x [set omax-x xcor]
   if xcor < omin-x [set omin-x xcor]
]
ask parties with [unit-opposition = 0][
   if xcor <= omax-x and xcor >= omin-x [set bool false]
]
Report bool
End

To-report coalition-average
let i 0
let avg 0
ask parties with [coalition = 1][
   set i i + 1
   set avg avg + xcor
]
Report avg / i
end

Notes: The source code is reduced. Some GUI- and feedback-functions are thrown out.