D2.3:
Final Versions of All Simulation

WP2 – Simulation Analysis

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Populism and Civic Engagement

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Abstract

In this report on Deliverable 2.3, we present the steps towards an Agent-Based Model (ABM) simulating the behaviour of voters and the positioning of political parties. The aim is to create what-if scenarios taking into account contextual changes, such as political crises as well as changes in parties' policy positions and voters' attitudes. Drawing on data from the Austrian National Election Study (AUTNES) and the Chapel Hill Expert Survey (CHES), we are able to map both demand- and supply-side characteristics. The computational simulation allows us to study the social and behavioural dynamics of populism and thereby contributing to the objective of Work Package 2. We present first results of the simulation analysis of applied strategies of voters and parties. This way, we are able to create first what-if scenarios that show how results of elections would change, if voters applied different strategies when deciding which party to vote for. In developing a simulation for the case of Austria as a reference model, we lay the foundation for more universal applications of ABM in political science.

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1. Introduction

Simulating voting behaviour accurately and in the context of a rapidly changing political environment is extraordinarily difficult and has thus rarely been attempted. The literature bridging the gap between simulations and empirical election research is exceedingly thin as there are numerous hurdles to overcome—both in terms of the subject matter to be simulated and the theoretical as well as epistemological assumptions underlying the different fields involved.
What is the aim here? Primarily, we want to test the feasibility of applying agent-based modelling to the research of voting behaviour, especially in the context of demand for, and supply of populism. In doing so, we hope to go beyond the traditional tools of political science and thus generate insights of voting research as is practised so far.

Why is this useful given that empirical voting research can generate relatively accurate predictive and explanatory models on voting behaviour? There are two major reasons: First, we hope to be able to shed light on what-if scenarios, which is otherwise notoriously difficult in normal social science research because it is not equipped to handle counterfactuals, as these would be considered speculative. Second, PaCE aims at developing counter strategies, which may require (the simulation of) purposefully changing certain input factors to see their effect. This is something we hope the computer simulation can accomplish better than the traditional analysis of causal relations. While for example regression analyses rely on variables collected from surveys or interviews, the agent-based simulation is able to add to this the potential to investigate the effects that have not yet occurred, but might play a significant role in the emergence and growth of populist attitudes and populist parties.

Applying agent-based modelling to the understanding of the processes involved in populist politics is truly innovative. This activity occupies half of WP2, along with the acquisition, processing and analysis of data from elections and surveys. These activities will contribute to PaCE objectives 2 and 3, namely:

> *Objective 2. Study the general and the specific causes of the three modes of populism (illiberal, nativist and anti-democratic) in European democracies – distinguishing between demand and supply side, internal and external causes.*
> *Objective 3. Study, propose and test policy-oriented responses to each of the three forms of populism.*

Yet, we also have to be realistic about what can and cannot be achieved in this short time period given that in the past 20 years we have barely seen progress on this front. When we mean *final versions of all simulations* we intend to create a blue print or modelling strategy that can be applied to all typical cases in our project. In short, we mean to identify a modelling strategy that allows us to convert survey and party data into decision rules to see how actors behave in certain contexts and react to external shocks which then be applied to all our cases. The relative finality thus refers to the strategy chosen but nonetheless refinements on the model will need to continue throughout the project. We reference these simulations by comparing the results with past election outcomes and polling data in our reference case – here, this is Austria for the reasons explained below. In this report, we explain how we achieve this conversion, discuss the existing gaps, detail the significant challenges, document and explain our proposed solutions, and show in detail where this process stands.
Specifically, the report is structured as follows: In Section 2, we explain the benefits of applying agent-based modelling (ABM) to questions of political science as well as what possible limitations of this method are. In Section 3, we present an overview of the literature that exists to date on the application of different forms of computer simulations in the social sciences. We applied ABM to the case of Austria and describe the characteristics of the case in Section 4. In Section 5, we explain how we conceptualized the simulation analysis using theories of voting and party behaviour as well as individual-level and expert survey data. We present the results of the analysis in Section 6 by reporting our results including the technical procedure, the problems we faced, and how future work might build on these results. Section 7 is a summary of the conclusions we are able to draw yet.

2. How Agent-Based Modelling Can Help Political Science

Agent-based modelling is a formal but expressive technique that has only been used occasionally in political science. As with any other technique it has its disadvantages but has unique advantages. It will not replace existing techniques but rather offers new opportunities for research. This presents a challenge to presenting ABM political science work, since many of its potential audience will try to understand it using existing approaches as a framework. In this note we explain what ABM does, discuss some of its distinct advantages and finally a couple of more specific ways we could use it to inform political science.

What ABM does

A formal model is one which precisely and unambiguously represents something (either observed data or some ideas). Such models can be communicated to other researchers without error or reinterpretation (although they can be and are interpreted in different ways). There are basically two kinds of formal model – analytic and computational. Analytic models are usually expressed in terms of mathematics (e.g. a regression equation) and their general properties can sometimes be mathematically inferred (if they are simple enough). Computational models are usually expressed in terms of a program, and their properties are inferred by running that program and recording the outcomes. Often there are random choices or values deliberately introduced in the execution to represent noisy or unknown micro-outcomes (say who an actor happens to talk to in a particular day) – in this case, each time one runs the simulation a slightly different outcome may result (in which case one tends to run the model many times and look for the outcome patterns that are common to all runs).
In an ABM, a set of actors are represented each by a separate object in the simulation, called "agents" (because they each act independently in the simulations). The rules for the behaviour of these agents are specified by the modeller and when the simulation is run then all these agents execute their behaviours in parallel, including interacting with each other. The outcomes of running such simulations can be very complicated, so these are typically abstracted to something more understandable, for example collecting measurements from the agents and combining these (e.g. a vote tally). This process is illustrated in Figure 1.

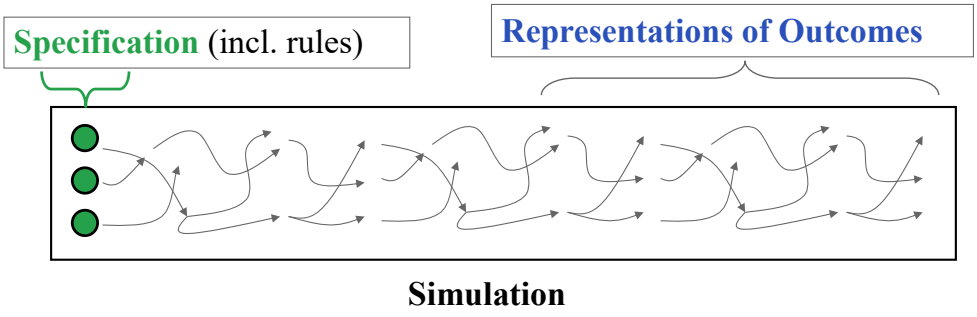

Figure 1. An illustration of what happens in an Agent-Based simulation

Thus, ABM allows us to formally represent complex processes involving the independent actions and interactions of many different actors. Such ABMs can, themselves, be complicated to understand, and the outcomes represented in different ways but are much less complicated than what they represent and have the advantage that they can be indefinitely experimented with and inspected at any level of detail desired. In this way

we can use their intermediate level of complexity to extend what we can formally represent and hence better understand.

Formally relate micro- and macro-levels

ABM is, so far, the only approach that *formally* represents the connections between micro- and macro-levels of phenomena. In most political science, discursive theory links the two levels supported by either analyses of quantitative survey data or qualitative interview data. ABM complements discursive theory with precise accounts of this relationship (both up and down) but these not as semantically rich as discursive accounts. This contrast is illustrated in Figure 2. In the work we are doing now, we are looking at what micro-level theories of behaviour might explain the known surveyed outcomes.

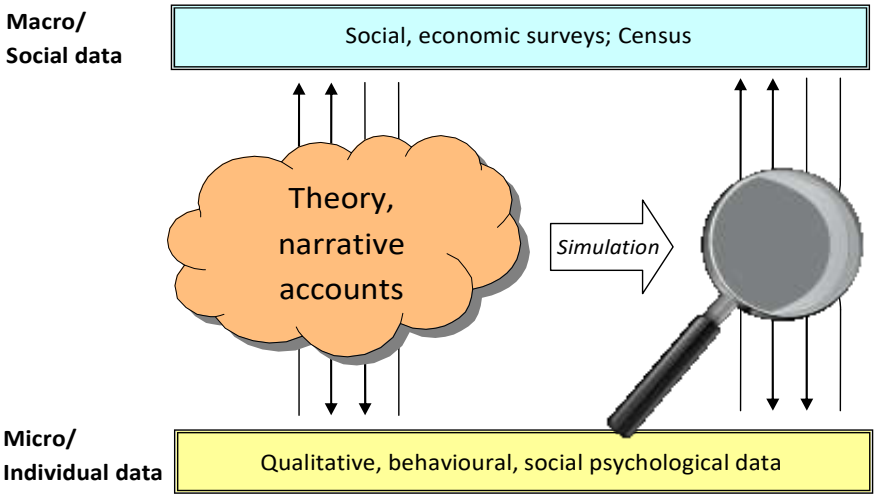

Figure 2. An illustration of role of ABM in making the connections between micro and macro-levels explicit

For this reason, ABM should help political science better understand the narrative theories that help it relate these levels – complementing these with alternative but precise accounts. Building ABMs that correspond to narrative theories is a particularly good way of unearthing implicit assumptions as the process of implementing ABMs result in a series of questions concerning process and mechanism. Frequently, ABMs relate micro- to macro-levels via short-lived meso-structures (groups, networks etc.) which may connect the levels in ways whose macro-outcomes are difficult to predict before constructing and running such a model.

Fully deal with actor heterogeneity and social embeddedness

Dealing with the full extent of human heterogeneity is hard. Not only do people have very different characteristics (e.g. attitudes and beliefs) but they also have different ways of making decisions based on these as well as inhabiting different contexts (e.g. social contexts) that further affect their responses. This heterogeneity is reflected in the data from surveys at the individual level, but this level of detail is beyond what the mind can take in, so that statistical summaries and tests are used that essentially smooth or average this into something more digestible (like a linear regression model or a significant/not significant test on a hypothesis).
ABM provides a way to understand agent heterogeneity in a non-linear manner. In an ABM each agent has its individual set of characteristics, and influence usually happens at the micro-level – between individual agents. These characteristics can include how it relates to other agents, for example what social network links it has or what groups it is associated with. The behavioural rules for different kinds of agents can be different – allowing the outcomes from different mixtures of agents to be explored. These behavioural rules can include any that can

be programmed (or learnt by the agent) – they are not constrained to (but could include) any one theory of action (e.g. economic rationality).

Furthermore, the behavioural rules can allow for the same agents to behave using very different processes in different contexts. This allows for the agent to be sensitive to its social context - for example, behaving one way when with like-minded people and another way when in public. In other words, the social embedding of political agents can be explicitly represented and explored. Agents need not be just a collection of individually acting agents nor socially determined by their society, but perceiving and acting through meso-level social structures of other agents. This is particularly important for modelling political processes.

Integrate different kinds of evidence

Since ABMs explicitly represent a number of different levels (micro, meso, macro) and are flexible in the kinds of rules this enables them to relate to a wide variety of kinds of evidence, including the following.

- The characteristics of individuals from survey data to an artificial population of agents in a simulation (for example by randomly resampling with replacement from the data to produce the set of agents in the simulation).
- Qualitative accounts or psychological theories concerning the way agents behave, make decisions or are influenced by what they perceive (influence from other agents, information in the media, impressions of leaders and parties etc.).
- Social network data concerning who talks to whom about politics among family, friends and others which can inform the social networks in between agents in simulations.
- Statistical averages (or other characteristics of the distribution) of population characteristics (e.g. socio-economic characteristics)
- Time series data about aggregate opinion such as that from opinion polls or elections to compare against some measure of the attitude of agents.
- Events in the form of sudden changes in economic or social conditions or a change in saliency of news reaching the agents.

ABM is the only formal technique that can relate to all these kinds of evidence. Thus this should complement discursive theories and accounts.

Represent 'hidden' processes of change

Much of what happens socially and politically is not directly observable, for example how an event (such as the 2015 European 'migration crisis') changed the way people decided how to vote. We can get information about attitudes and levels of trust by asking citizens in surveys but that does not get us to the cognitive *processes* that got them there – these are not directly observable (and self-accounts of these subject to considerable bias towards those that are socially acceptable). To some extent one can use simulations to get some sort of handle upon the assumptions behind or impacts of such hidden processes, but implementing them in ABMs and then comparing runs with this setup to (a) any observed data from cases studies or (b) to the results of alternative cognitive models.

Disadvantages of ABM

All techniques have disadvantages as well as advantages and ABM is no exception to this. The main disadvantage of the approach is its unconstrained nature – almost anything formalisable is possible. Thus there is a huge

'universe' of possible simulation specifications that might be applicable to any observed situation. The size of this universe can be limited down to something more manageable in a number of ways, including the following – each has its own corresponding difficulties.

- Evidence can be used to (a) help specify a model – e.g. informing what behavioural rules the agents should have, (b) calibrate the model – informing the adjustment of parameters that cannot be directly determined or (c) by checking the model outcomes against data (validation). This can make ABM development very data-hungry, resulting in an almost unlimited search for relevant data (which is rarely completely satisfied).
- Use theory or other assumptions to determine aspects of a model. But this makes the model dependent upon the reliability of these (depending somewhat on the use made of it).
- Arbitrarily decide what aspects might be included in the ABM and which not. However, this has the problem that the results might be very different depending on these choices and there is no limit as to how complicated one can make a simulation.

Different Potential Uses for ABM

All simulation modelling, including ABM, can be used for a very wide variety of uses. How a model is developed, calibrated, checked and applied depends on its intended use. Each possible use has implications for the interpretation, significance and generality of any conclusions. A list of seven possible uses is discussed in (Edmonds et al. 2019), but here we only look at those that might be immediately helpful in the context of political science.

Revealing hidden assumptions

The process of trying to develop a model is usually good for revealing the implicit assumptions or lacuna in the evidence behind our informal view of the phenomena of interest. Thus, going through this process can be revealing, even if no results are obtained. Natural language discourse is semantically rich, but is often vague or ambiguous – that is each person has their own interpretation of discursive descriptions and theories. When tries to formalise the processes concerned into a precise representation (rules, structures, characteristics, etc.) that all involved can agree with then this brings the disagreements and lack of precision to the surface. When developed somewhat it also provides a common frame, or reference for the terms used by participants – even if a term is somewhat imprecise in general, what it means in this model can be explicitly pointed to. This is often the most important contribution that comes out from ABMs.

Its use for abstract thought experiments or illustrations of an idea

The mechanisms, structures and processes involved in political science are complex – in the wild they can mix and combine in many different ways and through the interactions of many different agents, with complementary or counter-acting effects. Thus, the consequences of any theory, hypothesis, mechanism etc. are not always clear. In this case comprehensively exploring the outcomes of these using an ABM might be helpful – giving one an idea what outcomes might occur under what conditions. This is a kind of pseudo-mathematics, obtaining an understanding of the mechanisms, behaviours, structures etc. that one put into an ABM. This can be entirely non-empirical so this does not tell one anything of what is happening or will happen with observed political phenomena, but it might help with the following.

- It might show that certain outcomes could result from a particular set of mechanisms, structures etc. – a proof of concept or to show how something might possibly come about. For example, Hammond & Axelrod (2006) show how ethnocentrism might have evolved as a result of biological evolution, but gives

no indication of whether this was actually the case. This kind of demonstration is particularly useful when the proposed outcomes come about in a complicated way that is hard to follow in the human mind.

- Even an abstract model might provide a counter-example to something that is assumed. If an ABM setup includes some conditions, processes etc. that are plausible but the outcomes go contrary to what is assumed the results will then show that the assumptions regarding the outcomes are inadequate (e.g. more are required to get the target outcome). For example, Schelling (1971) showed how segregation could occur even when the agents involved only had very weak preferences for their own kind (e.g. they were happy with only 3 similar agents in a neighbourhood of 8). This showed that observed segregation was not necessarily caused by strong prejudice.
- It can be used to vividly illustrate an idea, even if the ABM is deeply flawed. The point here is to make real the working of an idea as a complex dynamic process. Such an ABM can be used as an analogy – a way of thinking about the phenomena concerned. However, this can be misleading when people project the model upon the phenomena they are thinking about and look at the phenomena only using that 'lens' – a particularly strong example of "Kuhnian spectacles" (Kuhn 1962).

The danger here is that the model is taken too seriously and interpreted as having empirical relevance even where none has, in fact, been demonstrated. For example a paper called "The evolutionary dominance of ethnocentric cooperation" (Hartshorn et al. 2013) has been widely and wrongly quoted as showing the efficacy of same-ethnicity cooperation compared to cross-ethnic cooperation. That was an entirely abstract exploration of the properties of the Hammond & Axelrod (2006) model.

Its use in supporting complex empirical explanations

The main empirical use of ABMs is to establish how a given set of processes, conditions, structures etc. could result in some observed data – in other words to support an explanation of that data (or aspects of that data) in terms of what was put into the model. If the processes, conditions, structures etc. are plausible, then this supports its plausibility, but it also shows *how* the outcomes might have come about (which could inform further research). In this kind of research there are usually some focus processes, structures or conditions which are used as the proposed 'causes' of the outcomes, with the other settings and coding either shown not to be critical to the outcomes, or providing an indication of the conditions under which this explanation would hold. Thus this supports a conditional explanation – that A (the focus processes, structures etc.) explain observed data B conditional upon C (the set of other assumptions that are necessary for getting those outcomes).

Other uses

There are, of course, other uses for ABMs, including as a core for a game, as a kind of description, as a teaching tool, as a way for stakeholders to communicate/negotiate concerning a complex domain or even to try and predict the future. These are not common uses for formal models within political science.

Limitations, Challenges and Potential Solution

While the potential advantages of ABM for understanding social and political interactions are clear, the challenges are daunting given the differences in training and assumptions between empirical social scientists and computer scientists. The former is trained to pursue parsimony, limit data input to essentials, treat covariates as problems or controls, avoid multicollinearity, and above all have a carefully defined theoretical argument before entering any data into a model. Social science research treats political actors as fickle, subject to change, and as

producing 'messy' data which require interpretation and are suited for making predictions only based on probabilities. In a single research operation there is typically a single unit of analysis operating on a distinct level of analysis about which we want to determine the most important causal influences informing the decision-making and structuring his or her behaviour. By contrast, ABM is data-hungry and purposefully less concerned with the typical theoretical assumptions in the field, in this case in political science, for they could be biased and might obscure other factors from outside the discipline that could indeed be more relevant. In ABM, the actors can interact on different levels, thus it is possible to mix, behaviourally speaking, parties with voters and draw on data from a variety of disciplines that can be integrated. However, these actors require clear and consistent decision rules and may also constantly influence each other. At the very core, there are also different epistemologies at work, reflecting somewhat different assumptions about society, individuals and their complex interaction. Tacking these challenges has been a major task.

3. Application of ABM in Political Science

Despite some early efforts starting already in the 1960s (e.g., McPhee & Smith 1962), computer simulation modelling has remained a rather marginal phenomenon in political science research. Publications are rare and articles using simulation methodology are hardly published in "mainstream" journals that define the present state of the art and research interest of the scientific community. Johnson (1999), in an early overview of the usage of computer simulations in political science, mentions two reasons for this reservation: a sociological and a substantial. From a sociological perspective, most political scientists are not trained in computer science. However, given the interdisciplinary character of PaCE, a fruitful cooperation between political scientists and computer scientists is possible. The second problem refers to the very nature of simulations, which Johnson summarized in the following way: "A simulation can accommodate a large number of variables and parameters, but in many cases there is a lack of substantive support for particular assumptions and a lack of resources with which to test their implications" (Johnson 1999, 1512). The validity of assumptions concerning the behaviour of voters and parties must therefore be a primary concern of research based on simulations. Social scientists are trained to enter data into an analysis based on carefully developed and well-supported theoretical assumptions. They are used to testing different hypothesis against one another, pursuing parsimony rather than an all-inclusive approach, and being highly selective about data, levels of analysis, serial correlation and the dangers of endogeneity. However, this is not how simulation experts approach the issue.

According to Johnson's (1999) assessment twenty years ago, especially agent-based modelling seemed to be relevant for future research. Following this approach, researchers "investigate the implications of various assumptions about how individual actors might learn about and adapt to the environment they experience" (Johnson 1999, 1512). These models "provide a methodology to explore systems of interacting, adaptive, diverse, spatially situated actors" (De Marchi & Page 2014, 1). Agent-based simulations are thus particularly suited for exploring the intersection of micro and macro phenomena as well as the consequences of interaction between socially embedded actors (Neumann & Lorenz 2020, 595). They are truly interactive models as they allow for exchanges of information and successive adjustment of positions as response to more information on the behavior of other actors. Agent-based modelling has therefore become an important methodology "in almost every field outside of the social sciences" (De Marchi & Page 2008, 71).

Within political science, agent-based simulations are still a rarely used methodology. They have been used amongst others to explore international relations whereas researchers on elections, parties, and voters, which is the topic of Work Package 2, have so far not often used this methodology. Most agent-based models of elections and party competition refer to spatial and rational choice models going back to Downs (1957). Voters thus follow the proximity function and always vote for the party which is closest to their (current) position (or which they assume to be most close). Parties, at least in specific circumstances, move to the median voter's position and become indistinguishable over time. But, as already mentioned, this strict interpretation of rational choice can be relaxed or even abandoned, which might facilitate the use of this methodology. Moreover, given that recent handbooks on methods in political science include agent-based modelling (e. g., Neumann & Lorenz 2020), it is possible that this approach will become more recognized and used in future research.

Research on the (strategic) behaviour of parties and voters, the overall topic of Work Package 2, started in the early 1990s with Kollman et al. (1992) who simulated the behaviour, thus the positioning, of two parties in a political space defined by 15 issue dimensions. In this simulation, parties at first do not know voters' preferences but receive this information indirectly through successive elections. Kollman et al. distinguish 'ambitious' (office-seeking) and 'ideological' (policy-seeking) parties. Both want to win, but the latter also want to position themselves near their own ideological ideal point. Downs' expectation of convergence is confirmed, especially when the length of campaigns increases or when parties have more information about voters. In a second publication, Kollman et al. (1998) additionally differentiated between types of voters whose varying shares in the population result in political landscapes (or political spaces) whose degree of ruggedness varies.

Laver (2005) reduced the political space to a more realistic two-dimensional configuration but extended the number of parties to five which is especially important for analyses of European party systems that are typically defined by patterns of multi-party competition. Like Kollman et al. (1992), he assumes voters' issues positions to be stable. All parties want to increase their share of votes by positioning themselves strategically in this two-dimensional space but by doing so they follow four different strategies (or heuristics): **Aggregator, Hunter, Predator**, and **Sticker**.

An *Aggregator* places itself "at the mean position on each dimension of the ideal points of current party supporters" (Laver 2005, 267). Laver is also especially interested in the role of party leaders and sees leaders' freedom to define policies in this first strategy as being rather constrained. The second adaptive rule gives leaders much more freedom and is called *Hunter*. This rule is "intrinsically adaptive, conditioning the direction of a policy move at cycle c on the success or failure of the previous move, made at cycle c – 1" (Laver 2005, 267). Parties, led by rather unconstrained leaders, thus move quickly through the political space until they find new voters. A more sophisticated third strategy is called *Predator*. Here, the leaders are again unconstrained, but parties (or their leaders) have to identify the largest party and their position: "A Predator observes the current sizes and policy positions of all parties at cycle c – 1. If it was not the largest party, it makes a unit move at cycle c toward the position of the largest party. If it was already the largest party, a PREDATOR stands still" (Laver 2005, 267). In order to provide a static baseline as well as to allow for the inclusion of ideologically motivated parties and thus highly constrained party leaders, Laver finally includes *Stickers* as fourth rule: "A STICKER never changes policy position, regardless of the ideal points of voters and the positions of other parties" (Laver 2005, 267). Laver also applies this model to the Irish party system and defines the two large conservative parties Fianna Fáil and Fine Gael as hunters whereas three smaller parties – the radical left WP/DL, Labour, and Progressive Democrats – are defined as stickers. This assessment is not based on an ad-hoc assessment but the

result of expert data on the willingness of parties to sacrifice policy objectives to get into office (Laver & Hunt 1992). In another publication, Laver and Schilperoord (2007) adapted the model to allow both for the emergence of new and the disappearance of old parties.

Laver's (2005) study was not only a theoretical contribution but also relied on "real world" data. Most studies using agent-based modelling of party competition, by contrast, were for a long time "an exclusively theoretical exercise" (Muis 2010) and provided no falsifications with real-world data. Muis' (2010) study on party competition in the Netherlands paved the way for combining simulations with real world development. Moreover, he extended the previous models by including the role of media as an additional factor. Parties, he argued, also compete for attention in the public sphere as they are not equally visible to voters. Following in the footsteps of this tradition, our ABM will also rely on real-world empirical data to validate the theoretical assumptions.

Muis and Scholte (2013) were the first to apply agent-based modelling in research on party populism. More concretely, they explored how populist radical right parties position themselves in a political space to find their "winning formula", a concept introduced by Kitschelt in his research on this party family (Kitschelt 1995). Muis and Scholte model the importance or salience voters attribute to various issues and differentiate between a limited number of party strategies, which are mostly based on Laver (2005): Sticker, Aggregator, and Hunter. A Predator strategy is not included, but the authors use Satisficing as new fourth strategy which is implemented "by setting a certain share of the vote as the aspiration level. When this level is reached or surpassed, parties stop moving around" (Muis & Scholte 2013, 33).

Before turning to the conceptualization of the simulation analysis, we need to briefly introduce the Austrian case and justify its selection for this endeavour.

4. Introducing the Austrian Case

What makes the Austrian case relevant is the fact that it includes one of the longest established and most successful radical right populist parties (i.e. nativist parties), the Freedom Party of Austria (FPÖ), which not only had to contend with challengers from the radical right (BZÖ, Team Stronach) but also from the centre-right. Even more importantly, the FPÖ served two periods in government, including holding important ministerial portfolios, and successfully negotiated two leadership changes attesting to the party's organizational depth and entrenchment in the Austrian political system. Since 1986 when it transformed from a more marginal right-wing nationalist party into a radical right-wing populist party, it had changed a number of core positions and adapted time and again to a fluid issue environment. The Austrian case also includes two major rival parties of the centre-right and centre-left which have pursued a variety of strategies (exclusion, adversarial engagement, accommodation, co-option) and several smaller parties located at various places of the ideological spectrum. Thus, this initial focus on Austria where we have excellent empirical data sources provides good foundation to examine party competition, the effect of leadership change, leader failure as well as of the influence of exogenous shocks such as the refugee crisis.

Synopsis of the Austrian political system

Austria has been a stable consensus democracy since the end of WWII. It was traditionally dominated by a major centre-left party, the Social Democrats (SPÖ), and a major centre-right party, the Christian conservative People's Party (ÖVP). In the first four decades after the war than 90% of the votes and seats in the legislature went either to the SPÖ or ÖVP. So as to minimize the political conflicts and partisan radicalization, post-war Austria embraced the idea of a consensus democracy based on a lasting, power-sharing mechanism between the Social Democrats and the Christian Conservatives. Over time, this system resulted in clientelist insider politics leading to numerous instances of party-political influence peddling.

A traditionally small third party, the Freedom Party of Austria had been positioned on the far right. In the context of economic growth and modernization the traditional Social Democratic and Christian conservative milieu disappeared prompting both major parties to move to the centre. This was the context in which the rise of the FPÖ and also of the Greens occurred. Both parties were at opposite ends of a newly emerging political spectrum: liberal, environmental, and cosmopolitan on one end and traditional, authoritarian, and protectionist on the other. They would continue to cut into the dominant electoral positions of Austria's two major parties. Over time the FPÖ surged, achieving eventually electoral support roughly equal to either of the more major parties. The party had initially catered German-nationalist, former Nazis war veterans but had undergone a transformation after 1986 when it became a radical right populist party. Subsequently it grew from about 5% in voter support to 26.9% by 1999 and was thus one of the largest such formations in any Western democracy, when it struck a deal with the ÖVP to enter the government as the nominal junior partner in 2000. Unprepared and unfit for government office, the FPÖ collapsed and split between a more moderate office-seeking wing, which subsequently became its own party (Alliance Future Austria, BZÖ) and the radical rump Freedom Party, which moved further to the right. The rump-FPÖ left government, moving sharply to the right in the sociocultural domain while staying toward the left on economic policy. These positions were designed to rebuild the FPÖ's radical electoral base after years of mainstreaming.

Between 2008 and 2013 a renewed SPÖ-ÖVP coalition was preoccupied with the fallout of the global economic and Eurozone financial crisis. This also meant that, after the 2008 elections, the programmatic orientation of the ÖVP temporarily shifted away from its restrictive positions on law-and-order and multiculturalism. The 2013 elections resulted in further losses for both SPÖ and ÖVP, which had gone through its fourth leadership change in a decade. Moreover, from 2014 through 2017 the FPÖ was leading in opinion polls most of the time whereas the Christian Conservatives were mostly in a distant third place. In 2013 another small party displaying populist traits and posing a challenge to the FPÖ (even though only temporarily) was Team Stronach. However, it largely faded politically soon after the election.

In the wake of the refugee crisis 2015/16, the sociocultural issue dimension reasserted itself in profound ways. The principal advocate for the ÖVP's reorientation became the 31-year-old Foreign Minister Sebastian Kurz, who was a critic of the SPÖ-ÖVP government's handling of asylum and immigration policy. When the Conservatives pushed out yet again their party leader and elected Kurz to become party chair, he ended the coalition with the SPÖ and sharply reoriented the Conservatives' sociocultural positions. Analyses of manifesto and speech data suggest that on a wide range of policy areas, the ÖVP not only adopted policy positions formerly 'owned' by the FPÖ, but also the FPÖ's rhetoric and wording in issues of 'national sovereignty' (Heinisch, Werner, and Habersack 2019).

In the 2017 election, the ÖVP emphasized immigration above all else despite the FPÖ's relative moderation in the preceding period. An ÖVP-FPÖ government was eventually installed in 2017 but ended prematurely following a scandal implicating the Freedom Party leader ("Ibiza Affair"). After the snap elections later in 2019, in which the SPÖ lost 5.7 percent of the votes and reached its all-time low after 1945, the Christian Conservatives formed a government with the Greens.

5. Conceptualizing the Simulation

A major problem whose solution seemed to elude our team for some time was to develop decision rules for modelling agent behaviour that made sense for both political scientists and computer scientists but which differed from the classical theories on political behaviour. These typically make competing assumptions about cause and effect and seek to identify the relative importance of input factors. At the same time for political scientists even the strongest causes would not result in uniform behaviour while only certain scenarios and outcomes are seen as consistent with expectations and thus valid. Computer scientists by contrast are in some sense more and in another sense less restrictive. The agents are assigned clear and non-overlapping behavioural scripts and are thus restricted in some sense whereas at the same time their context can be subject to a variety of input data also from outside of political science. In the following we show how we approached the simulation of political behaviour based more in personality type than models of voting behaviour.

5.1. Voting Strategies

Agent-based modelling is based on a set of assumptions (rules) about the way agents behave. Parties may follow different strategies called Predator, Sticker, Aggregator, Hunter, or Satisficing (see above). However, how can we model the behaviour of voters? One major advantage of agent-based modelling is that we do not have to use a uniform strategy for all voters such as simple proximity voting (Downs 1957) or its directional counterpart (Rabinowitz & Macdonald 1989).

Lau et al. (2018), for example, distinguish between five groups of voters based on the way they decide which party to vote for. These five "decision strategies" are called Classic Rational Choice, Confirmatory, Fast and Frugal, Heuristic-Based, and Gut (Lau et al. 2018, 913-915). Classic Rational Choice defines voters as actively searching for information on all issues and parties. Voters compare all parties and decide after careful considerations. Whereas Classic Rational Choice decision making starts at zero, Confirmatory decision-making, the second strategy, is heavily influenced by voters' long-term relations to parties, such as their party identification. For example, if the election is run by individual candidates, such as presidential elections in many European countries, these voters need only to find candidates' party affiliation to decide which candidate they prefer. Fast and Frugal, by contrast, assumes that candidates are primarily motivated by efficient decision making. Voters do compare the positions of parties but restrict this effort to the most important issues. The heuristic-based fourth strategy is similar, but decisions can be taken based on various heuristics provided by numerous sources such as discussions with friends and neighbours – not only by a direct comparison of, for example, policy positions. Gut decision-making, finally, is strictly affective; voters do not search for any kind of information, at least not systematically.

Lau et al. (2018) use original survey data (and experiments) to assess these strategies but it is also possible to identify these voter groups when using secondary data such as survey data from national election studies. PLUS tried to define the five voter groups by using the following variables in the AUTNES PRE- and POST Panel Study 2013 (Kritzinger et al. 2017):

We operationalize the users of the **Classic Rational Choice** strategies as those respondents, who voted for the party with the least positional voter/party distance on the economic and cultural left-right dimensions, measured via items asking for positions on taxes and immigration.

We use the question Q27 in the AUTNES survey to assess the respondent's own position on taxes and social security benefit, i.e., if the respondent prefers lower taxes and therefore fewer social security benefits or higher taxes and more social security benefits:

> "Jetzt zu einigen politischen Streitfragen. Manche wollen **niedrige** Steuern und dafür **wenige** Sozialleistungen, andere wollen **hohe** Steuern und dafür **viele** Sozialleistungen. Wo würden Sie sich selbst auf einer Skala von 0 bis 10 einordnen, wenn 0 bedeutet, dass Sie für **niedrige** Steuern und dafür **wenige** Sozialleistungen sind, und 10 bedeutet, dass Sie für **hohe** Steuern und dafür **viele** Sozialleistungen sind?"
>
> – niedrige Steuern und dafür wenige Sozialleistungen (0) – hohe Steuern und dafür viele Sozialleistungen (10) (*Now to some political issues. Some want low taxes and few social benefits, others want high taxes and many social benefits. Where would you rank yourself on a scale of 0 to 10, if 0 means you are for low taxes and for few social benefits, and 10 means you are for high taxes and for many social benefits?" - low taxes and few social benefits (0) - high taxes and many social benefits (10)*)

This position is compared to the perceived position of the parties SPÖ, ÖVP, FPÖ, BZÖ and the Greens in Q28:

> "Und wofür stehen Ihrer Ansicht nach die politischen Parteien auf dieser Skala?" (*What position do the political parties stand for on the same scale?*)

Similarly, we use the question Q29 to assess the respondent's own position on migration to Austria, i.e. if s/he favours softer or harder stances on immigration.

> "Jetzt zur Frage der Zuwanderung. Manche wollen, dass Zuwanderung nach Österreich **nur in Ausnahmefällen** möglich ist. Andere wollen, dass Zuwanderung nach Österreich **offen** geregelt ist. Wo würden Sie sich selbst auf einer Skala von 0 bis 10 einordnen, wenn 0 bedeutet, dass Zuwanderung nach Österreich nur in Ausnahmefällen möglich ist, und 10 bedeutet, dass Zuwanderung nach Österreich offen geregelt ist?" – nur in Ausnahmefällen (0) – offen geregelt (10) *(Now to the question of immigration. Some want immigration to Austria to be possible only in* ***exceptional circumstances****. Others want immigration to Austria to be* ***loosely*** *regulated. Where would you place yourself on a scale of 0 to 10 if 0 means that immigration to Austria is only possible in exceptional cases and 10 means that immigration to Austria is openly regulated? - only in exceptional cases (0) - openly regulated (10)*)

Again, the survey asks for the perceived positions of the same parties:

> "Und wofür stehen Ihrer Ansicht nach die politischen Parteien auf dieser Skala?" (*What position do the political parties stand for on the same scale?*)

We code respondents as users of the Classic Rational Choice strategy when they vote for the party with the minimum distances between the own and the respective party's position, if valid measurements are available for both dimensions.

Respondents we categorize as belonging to the **Confirmatory Strategy** are those, who have a firm party identification and retrospectively answer to have voted for this party in the 2013 National Election. Those respondents who state that they feel closer to one party than to others are subsequently asked, which party this is in question Q43:

> "Um welche Partei handelt es sich dabei?" *(Which party was this?)*

In the post-election survey, the respondent is then in question Q15 asked to state which party s/he has voted for:

> "Welche Partei haben Sie bei dieser Wahl gewählt?" *(Which party did you vote for?)*

We code those voters as users of the Confirmatory strategy who voted for the party they feel closer to.

The **Fast and Frugal Strategy** is used by those respondents, who vote for the party they see as being best able to handle the most important issue, according to our operationalization. In Q3, respondents are asked, which party they see as being best able to handle the most important issue in Austria:

> "Welche Partei ist Ihrer Meinung nach am besten geeignet, mit diesem Thema umzugehen?" (*In your opinion, which party is best suited to handle this issue?*)

Again, using Q15, we check for who the respondent states having voted for in the post-election survey. We identify them as users of the Fast and Frugal method, when they voted for the party which is seen as being most competent to handle the most important issue.

The group we created of the **Heuristic-based voters** is based on the respondents' answers to the questions Q66 asking for the frequency of political discussions with close family members, friends, colleagues, and neighbours and the question Q67 asking for how often they try to persuade someone:

> "Wie häufig diskutieren Sie im Allgemeinen mit den folgenden Personen über politische Themen – oft, manchmal, selten oder nie? Wie ist das…" – 1- mit Ihrer nahen Familie?, 2- mit engen Freunden?, 3- mit Kollegen aus Arbeit, Studium oder Schule?, 4- mit Nachbarn? – oft (1) – manchmal (2) – selten (3) – nie (4) (*In general, how often do you discuss political issues with the following people - often, sometimes, rarely, or never? How about..." - 1- with your close family?, 2- with close friends?, 3- with colleagues from work, study, or school?, 4- with neighbors? - often (1) - sometimes (2) - rarely (3) - never (4)*)

and

> „Wenn Sie bestimmte politische Ansichten haben, versuchen Sie dann oft, manchmal, selten oder nie andere Personen davon zu überzeugen?" – oft (1), manchmal (2), selten (3), nie (4) (*When you have certain political views, do you often, sometimes, rarely, or never try to convince other people of them?" - often (1), sometimes (2), rarely (3), never (4))*

We categorize those respondents who discuss frequently with peers, but never or rarely try to persuade someone as the users of the heuristic-based strategy. Given the variables available, we have to resort to a rather indirect operationalization of this decision-making strategy.

The **Go-with-the-gut strategy** is operationalized as the respondents who vote intuitively, i.e., who indicate to only decide for which party they vote on the day of the election. The question Q16 in the survey asks specifically for when the respondent has decided which party s/he voted for – on election day, some days before election day, one to two weeks or even longer before election day:

> "Und wann haben Sie sich ungefähr dafür entschieden, diese Partei zu wählen? Schon länger vor der Wahl, 1 bis 2 Wochen vor der Wahl, wenige Tage vor der Wahl oder erst am Wahltag selbst?" – länger vor der Wahl (1) – 1-2 Wochen vor der Wahl (2) – wenige Tage vor der Wahl (3) – erst am Wahltag

selbst (4) (*And roughly when did you decide to vote for this party? Long before the election, 1-2 weeks before the election, a few days before the election, or only on election day itself?" - long before the election (1) - 1-2 weeks before the election (2) - a few days before the election (3) - only on election day itself (4)*)

5.2. Opinion formation

While parties may adapt their positions in the n-dimensional policy issue space according to their strategy (see section 3), voters in current agent-based models of party competition usually remain in place. It is common practice to assume that public opinion on policy issues follows a normal distribution (Laver & Sergenti 2012, p.30) and does not change over time. Muis & Scholte (2013) is a rare example of an ABM using empirical data – in this case, a survey of the Dutch voting population held before the 2006 parliamentary elections – to initialise voters' positions in the policy issue space, but even their voters do not change their opinions during the simulation. Our model is therefore pushing the state-of-the-art in that it both uses empirical data to initialise the voter agents and implements social processes to allow voters to adapt their positions over the simulated time period.

Informal political discussions with family, friends or other acquaintances have been found to influence political attitudes and behaviours of voters (Huckfeldt & Sprague 1991, McClurg 2003). The social network of voters is thus an important component of a model of voting. While empirical data on networks is rare, studies have shown that the size of political discussion networks is small: people tend to talk to 0-5 other people about politics (Lake & Huckfeldt 1998). In absence of explicit network data for the Austria case study, our model must initialise the social network by applying a plausible algorithm. We adopt a process with both random and homophilic aspects: each voter forms links with 0-2 other voters at model initialisation, choosing the most similar in age, education and residential area from a pool of randomly chosen individuals. Since links are bi-directional, this results in a social network where nearly all voters have between 0 and 5 connections to other voters. The model offers the option to let the network evolve during the simulation, i.e. voters may drop a link or form new links with different people, to account for changes in friendships, work colleagues or acquaintances over time.

At each time step, voters may select several of their social links to have a discussion about a policy issue and influence the other's opinion. The chance to start a discussion depends on their level of political interest[1] and the chosen discussion frequency (a model parameter). After a discussion partner is selected randomly amongst a voter's connections, the issue to discuss is determined. This will usually be one of the issues the voter finds most important; only if no such issues exist (missing entries in the underlying survey data), one of the modelled issues is chosen at random. If the voter is more strongly convinced of their opinion, i.e. puts a higher importance on this issue, the voter's discussion partner will move their own position towards that of the voter with a certain probability (model parameter 'voter-adapt-threshold'). Most simulation runs reported in section 6 have been undertaken with this version of the model.

[1] We assume that voters with no political interest do not initiate political discussions. This does not mean that they will never be influenced by others since they can be picked as a discussion partner by one of their connections with a higher political interest level.

To investigate effects of the opinion formation process on model results, we have implemented an additional process based on a model of political polarisation dynamics (Baldassarri & Bearman 2007). Similar to our model, voters in this model have opinions on several different issues (four in this case), which directly translate to positions in the issue space. In contrast to our model, Baldassarri and Bearman assume that interest in an issue can be represented as extremity of opinion: the more extreme the opinion (either positive or negative), the higher the interest this person takes in the issue. An opinion of 0 indicates no interest. Opinion change in this model depends on (i) whom you interact with and (ii) the outcome of such an interaction.

Interaction partner selection is determined by the agents' overall level of interest (higher interest results in more interactions) and their similarity of opinions, or ideological distance. The ideological distance of two agents a and b at time t is defined as a normalised Euclidean distance: it is the sum of their Euclidean distances in each of the dimensions divided by the maximum of these distances for all pairs of agents. The model makes the realistic assumption that agents, who have never interacted before, do not know the exact positions of the other agent. Instead of using the exact ideological distances in the selection process, agents therefore rely on perceived ideological distances. At the beginning, this is initialised as the average ideological distance over all pairs of agents. Whenever two agents interact, their perceived ideological distance is updated to their actual ideological distance at that time, i.e. they gain knowledge about the position of their interaction partner. The selection process is operationalised in the model as randomly selecting a number of agents directly proportional to the actor's level of interest and then choosing from this pool the actual interaction partners with a probability inversely proportional to the agents' perceived ideological distance.

During an interaction, agents will discuss the topic in which both are most interested, i.e. the issue with the highest joint relevance. This is defined as the issue for which the sum of their absolute opinion values is maximum. Using the absolute values ensures that agents do not need to agree on the issue, as long as they are both interested in it. Discussions between opponents on a particular issue are therefore possible. The result of such a discussion is bidirectional: both agents change their position on the issue, but the magnitude of change depends on their level of interest; the higher the interest, the smaller the change. The direction of change (positive or negative) is determined by the combination of agent opinions: if they both agree (both opinions are positive or both are negative), they both keep moving in the same direction as before, thus reinforcing their beliefs but at the same time reducing their ideological distance. If they disagree (one opinion positive, the other negative) and (mostly) disagree on the other issues, they keep moving in the same direction as before. But as they are now heading in opposite directions, they increase their ideological distance. Only in the case of disagreement on the issue under discussion but agreement on the other issues do they compromise: each one heading in the opposite direction as before, thus reducing their ideological distance.

The social network of the agents arises from their patterns of interactions. At each time step, an agent a forms a link with another agent b if the number of their interactions is significantly higher than it would be if they had chosen the partners randomly. To this end, Baldassarri and Bearman define a measure of preferential association A^t_{ab} for two agents a and b at time t as the difference between the observed (Obs^t_{ab}) and expected (Exp^t_{ab}) number of interactions divided by the expected number of interactions. A value close to zero indicates that a and b interact at chance level whereas deviations from zero indicate social selection with a avoiding (A negative) or preferring b (A positive) as a discussion partner (Baldassarri & Bearman 2007, p.797). A link between a and b is established only if their preferential association measure A^t_{ab} exceeds agent a's average preferential association measure by twice the standard deviation.

This opinion formation process is computationally resource intensive as it needs many pairwise calculations over the set of all agents per time step. Scaling up from 100 agents (Baldassarri and Bearman's original model) to more than 3000 agents (our model) with both memory usage and computation time rising exponentially posed severe technical problems and made the model practically infeasible. While we are working on solutions to speed up the execution time we were forced to run experiment with fewer agents (up to 500), drawn randomly from the survey data-fed pool of 3266.

5.3. Issue salience

Since we strive to simulate not just a short pre-election campaign period but at least the four years between two national elections in Austria (2013 to 2017), we need to account for a change in issue salience over time. While some topics stay close to the heart of people (for Austria e.g. unemployment), others gain and lose in importance in the public opinion. The media is involved in this process and may act as an amplifier or filter by applying their agenda-setting power (McCombs 2004, Geiß 2019). In the absence of detailed media analysis data for the specified time period in Austria we have chosen to use issue salience in the public opinion as available in the EuroBarometer survey as a proxy. The EuroBarometer contains two data sets per year for the time period in question. We are focussing on the answers to the question "What do you think are the two most important issues facing (OUR COUNTRY) at the moment?" for Austria. After matching the EuroBarometer categories to the seven issues represented in our model (taken from the AUTNES and CHES surveys), we rescaled the data so that the sum of all issues equals 100%. Figure 3 shows the resulting time lines. The sudden spike in the salience of the 'immigration' topic coinciding with the migrant crisis of 2015/16 is clearly visible.

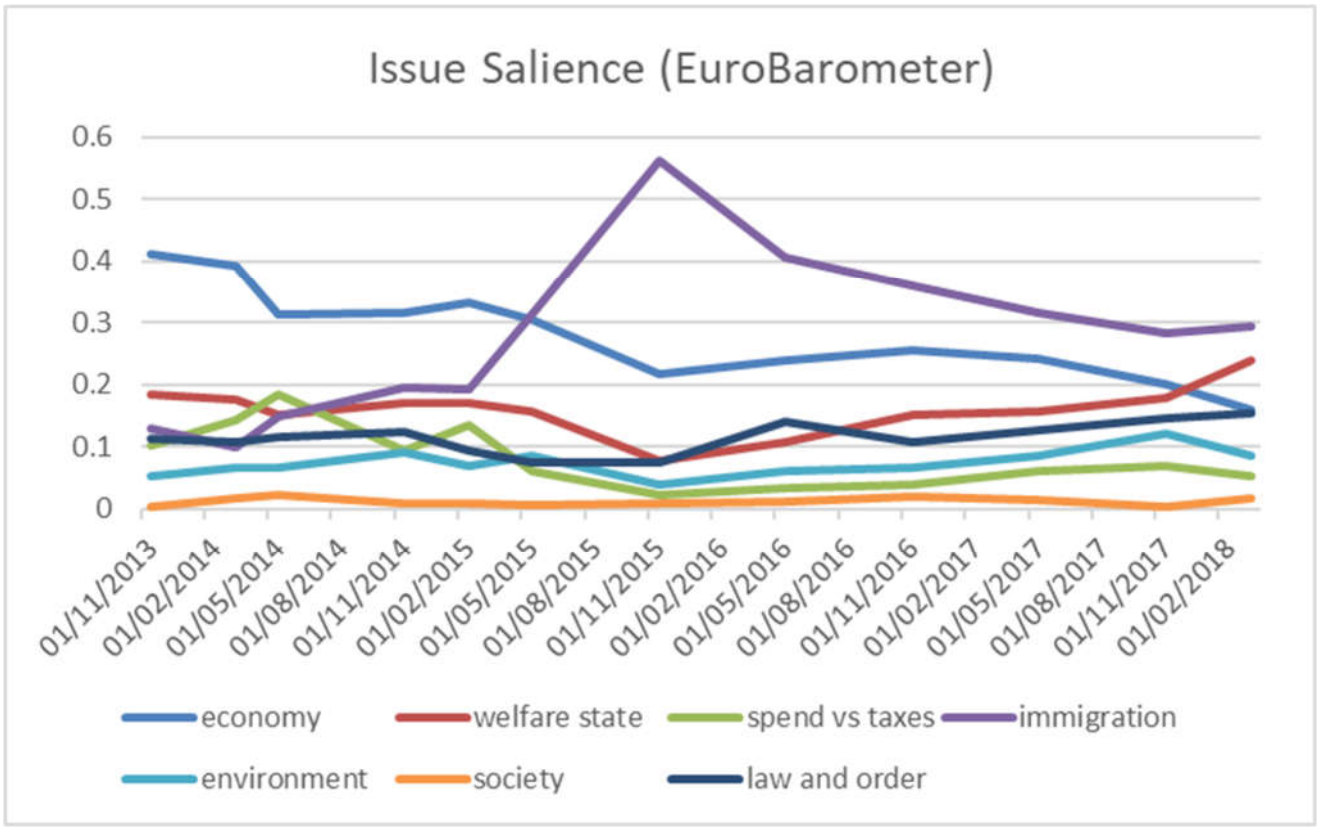

Figure 3: Salience of the modelled seven issues in the Austrian public opinion over time

The salience values for each issue along with the respective dates converted to simulation time are stored in a suitable data structure at model initialisation so that they are easily accessible during the simulation. In a first attempt to influence voter opinion, these values are applied as probabilities to select the topic to talk about during voter interactions.

6. Results of the Simulation Analysis

6.1. Comparing Voter Decision Strategies

One area that our model improves on is the incorporation of different decision strategies for voters with regard to party choice. It is common practice in existing agent-based models of the complex system of voters, parties and their interactions to assume that (a) all voters use the same strategy and (b) this strategy is choosing the ideologically most proximate party, i.e. the party closest to them in all modelled dimensions. In the terminology of Lau et al. (2018) this is called Classic Rational Choice. We have undertaken experiments with our model using the software *NetLogo* to investigate the effect of different voter decision strategies. All simulation runs use the same model specification:

- 3266 voters, initialised from the AUTNES dataset (Kritzinger et al. 2017)
- 7 parties, initialised from the Chapel Hill Expert Survey (CHES) on party positions (Polk et al. 2017)
- Party strategy assignation as follows: SPÖ and ÖVP use 'aggregator', FPÖ uses 'hunter', all other parties (Greens, BZÖ, NEOS, Team Stronach) use 'sticker'. The party roles were assigned based on the following rationale: The large centre parties (Aggregators) pursue median voter strategies and thus tend to aim for broad appeal trying to "aggregate" voters and build broad centrist electoral coalitions. Smaller parties (Stickers) are associated with a particular issue that works for them and maximize the support in certain voter segments. They tend to stick with the policies that work for them and match their brand image. The FPÖ (Hunter) is neither a centre party nor a small party. Thus, it cannot be content with a niche strategy but keeps moving in the same ideological direction if the previous move in that direction was successful.
- Default opinion formation process with set voter adaptation threshold (0.1), varying discussion frequency (none, medium, high), and varying social network evolution (static, dynamic)
- A time step represents a two-week period, the simulation thus runs for 104 steps representing 4 years

The following figures show time series of the parties' vote shares taken from typical runs. As can be clearly seen, the type and mix of voting decision strategies present in the population of voters have a huge impact on the outcome of the simulated elections. If all voters apply the 'Rational Choice' strategy as is usual in other models, the SPÖ wins a comfortable majority of the votes, while the ÖVP comes in as the second largest party (see Figure 4). This will be mostly due to both parties applying the 'aggregator' strategy, which has them moving towards the centre of their supporters and taking support away from the other parties. An interesting outcome of this scenario is that the SPÖ and ÖVP tend to converge on every dimension, except for the socio-cultural one dubbed 'society' in the model. Figure 5 (left) shows how the SPÖ (red) and ÖVP (blue) clearly divide the electorate on this issue, whereas their supporters are jumbled together on other issues due to the parties aiming for the same ideological spot.

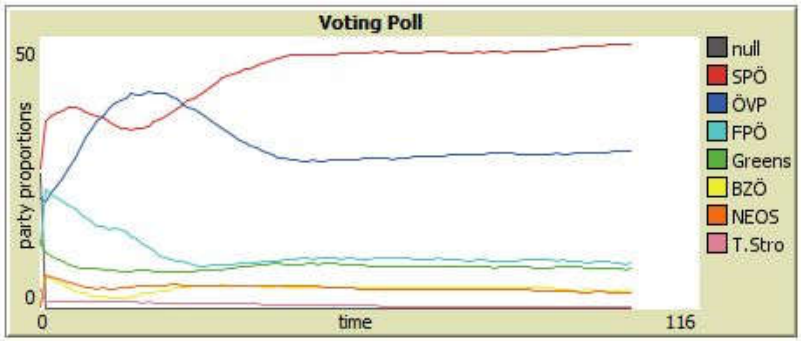

Figure 4: Evolution of vote shares over time with all voters using 'Rational Choice'

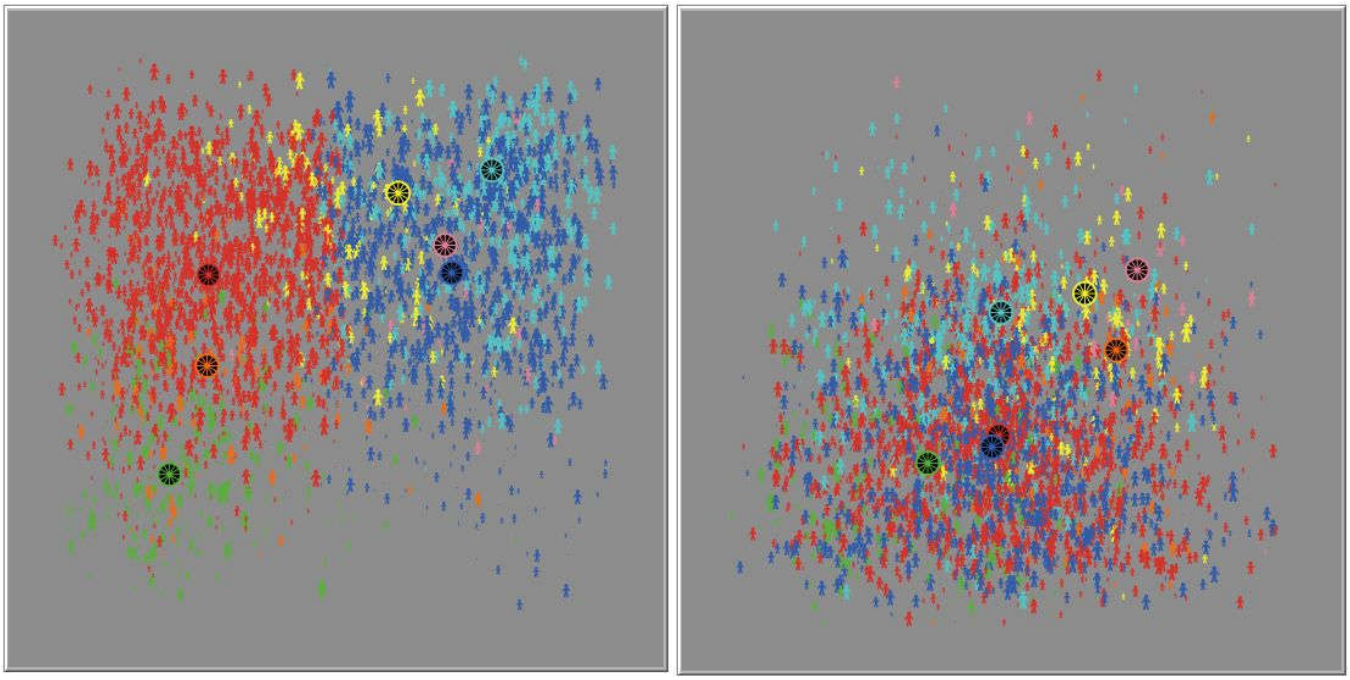

Figure 5: Voters and parties at the end of a simulation run with all voters using 'Rational Choice'. On the left, the x-axis represents the issue 'society', the y-axis the 'immigration' issue. On the right, the x-axix represents the issue 'economy', the y-axis the 'environment' issue.

Further experiments with a single voting strategy for all voters were conducted for the strategies 'Fast and frugal' (see Figure 6) and 'Heuristic-Based' (see Figure 7). The former strategy lets voters concentrate on their two most important issues and weigh their distance to the parties' positions with the importance they give these issues. After an initial phase of upheaval, the aggregator strategies of SPÖ and ÖVP manage to (re-)gain them support so that they end up together with the Greens at around 22% each; single runs will differ in the exact percentages and order of the three parties but the overall result is the same, with the Greens usually managing to win first place. Social influence mitigates this only a little.

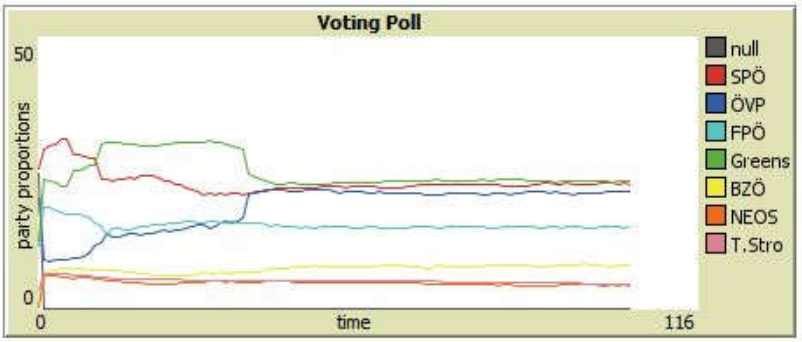

Figure 6: Evolution of vote shares over time with all voters using 'Fast and Frugal'

The 'Heuristic-Based' strategy has voters follow the recommendations of their social network. This is operationalised in the model that they decide to vote for the party the majority of their connections support; in case of a tie they choose randomly between the two most supported parties. This scenario differs quite strongly from the previous ones in that it is the only one retaining a sizeable portion of the electorate not supporting any of the parties (shown as supporting the "null" party in Figure 7). It is also the only scenario resulting in distinct pathways: While some runs show the vote shares of all parties converging (see Figure 7, top), others have a clear majority for the non-voters (Figure 7, middle), and a third group leave the SPÖ with a majority (Figure 7, bottom). This is typical behaviour of classic opinion dynamics models. Not surprisingly, this scenario can be classified as such since all voters' opinions rely solely on the opinions of their neighbours in their social network.

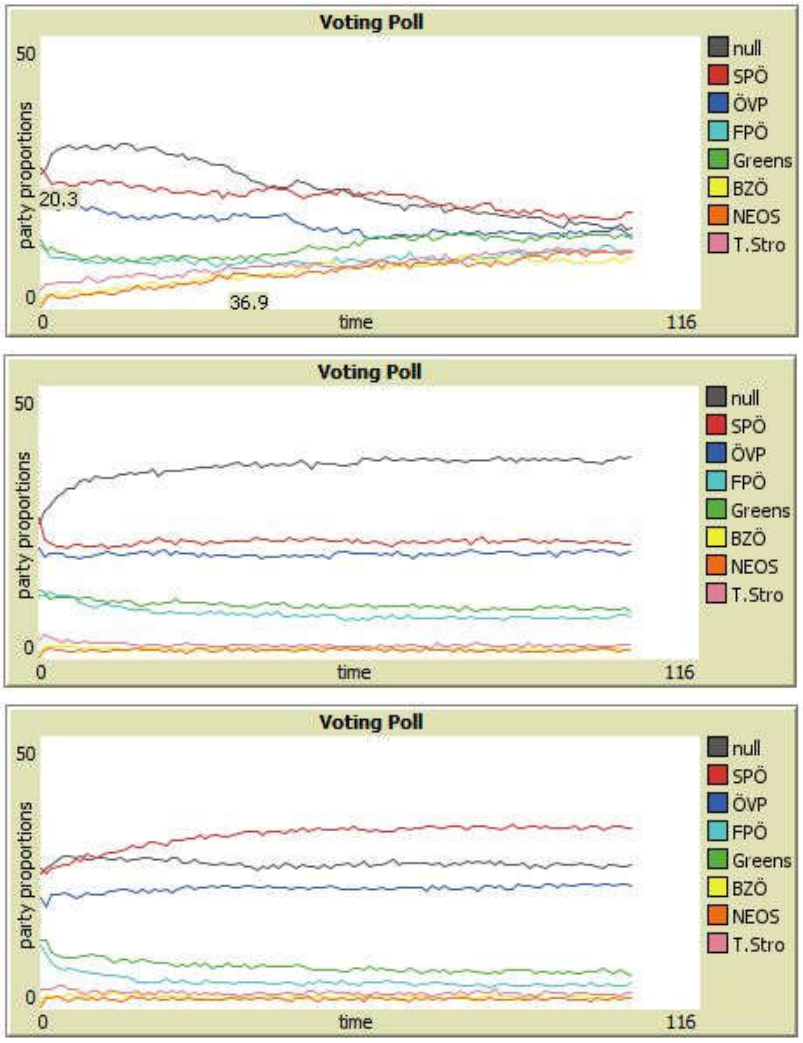

Figure 7: Evolution of vote shares over time with all voters using 'Heuristic-Based' (Based on three different runs)

In a last scenario, we applied the mix of strategies as identified by the analysis of the AUTNES data in section 5.1. The proportion for non-overlapping categories are as follows: Rational Choice: 11.7%, Confirmatory: 38.4% Fast and Frugal: 39.3%, Heuristics-Based: 5.9%, Go with Gut: 4.7%. This results in the SPÖ becoming the largest party (around 28-30% of the vote share), the ÖVP and the Greens the next largest (around 18% each), the FPÖ and non-voters both around 11% and the other parties (BZÖ, NEOS, TS) come all in under 5% (see Figure 1).

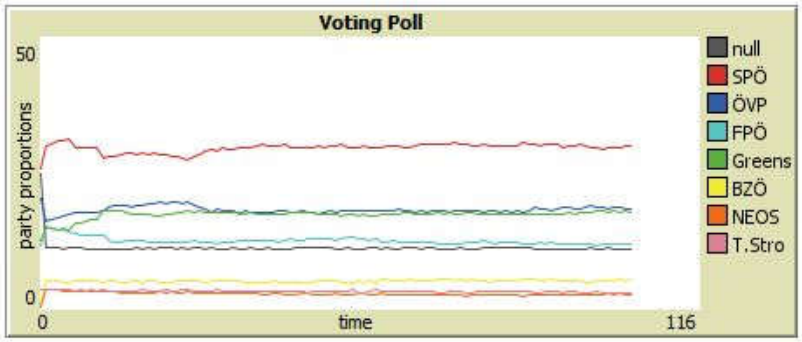

Figure 8: Evolution of vote shares over time with a mix of strategies

Results averaged over ten simulation runs for each variation of parameters demonstrate that neither the discussion frequency nor the social network structure have a big impact on the outcome; the 'election results' remain stable across all runs.

6.2. Adapting Party Strategies

During the experiments discussed in the previous section we noticed that both the SPÖ (social democrats, centre-left) and the ÖVP (conservatives, centre-right) applying the 'Aggregator' strategy can lead to a situation where the ÖVP becomes more left-leaning than the SPÖ on one or more dimensions. This can happen because the strategy purely searches for the centre position of the current supporters without constraints. While this is most prominent in scenarios where all voters use either 'Rational Choice' or 'Fast and Frugal' as their decision strategies, it nevertheless seemed a rather unrealistic outcome for the ÖVP to promote more public spending or a stronger welfare state than the SPÖ (see an example in Figure 9).

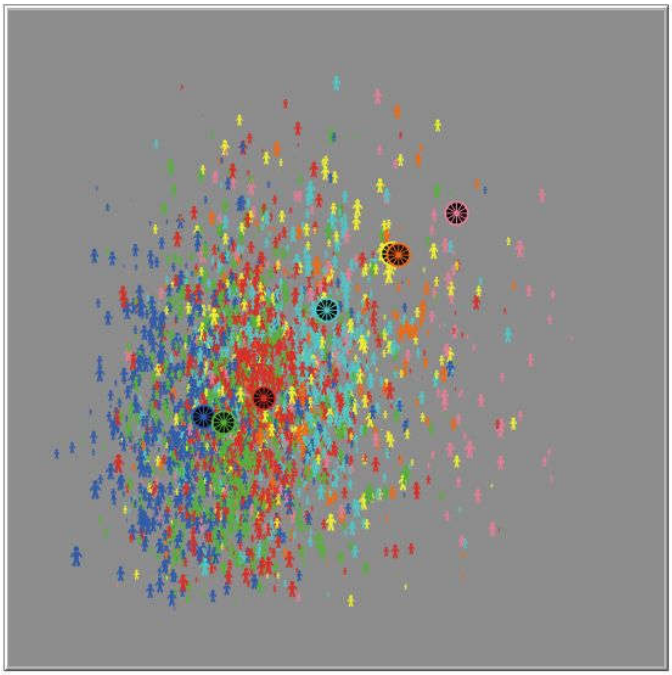

Figure 9: Voters and parties at the end of a simulation run with all voters using the 'Fast and Frugal' strategy. The x-axis represents the 'welfare state' issue, the y-axis the 'spend vs. tax' issue.

We decided to adapt the 'Aggregator' strategy so that a party would not move on all dimensions but only on the two or three dimensions it deemed most important. For the SPÖ these are 'welfare state', 'public spending vs. taxes' and 'economy' in this order, and for the ÖVP these are 'economy' and 'public spending vs. taxes'. Experiments with this adapted version of the 'Aggregator' strategy and different mixes of voter decision strategies showed that it is not successful: Neither does it guarantee that the ÖVP does not become more left-leaning than the SPÖ nor does it perform well in securing voter support for the ÖVP. The SPÖ is less affected: it has no problems staying the biggest party in scenarios with voters applying the realistic mix of strategies or all voters using 'Rational Choice' but loses to the Greens when voters all apply the 'Fast and Frugal' strategy. More interesting is the performance of the FPÖ in these experiments. It is assigned the 'Hunter' strategy, which seeks votes by moving further in the same direction as long as its vote share increases; otherwise it turns around and makes a random move (policy change) in a different direction. In our model this strategy only considers the party's most important issues (which are 'immigration' and 'law and order' for the FPÖ), similar to the now modified 'Aggregator'.

The 'Hunter' strategy was always outperformed by the pure 'Aggregator' strategy in the previous round of experiments and still only secures the FPÖ a small part of the vote share (about 12-14%) now with the mix of voter decision strategies. But in the scenarios with all voters either using 'Rational Choice' or 'Fast and Frugal' and the two major parties SPÖ and ÖVP applying the modified version of the 'Aggregator' strategy, it shows what it is capable of. Best results are obtained when all voters adhere to the 'Rational Choice' strategy: while the SPÖ still remains the biggest party, the FPÖ easily beats the ÖVP to second place (see Figure 10, top). All voters using 'Fast and Frugal' favours the Greens but the FPÖ manages to come in third, whereas the ÖVP is relegated to the small parties (see Figure 10, bottom).

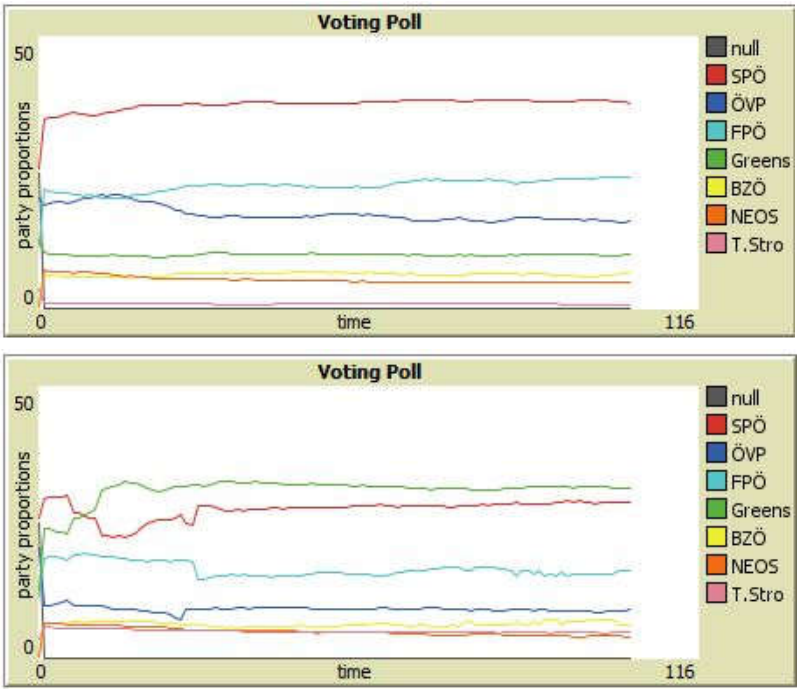

Figure 10: Comparative success of the 'Hunter' strategy (FPÖ) when SPÖ and ÖVP use the modified 'Aggregator' strategy. Voters are all using 'Rational Choice' (top) or 'Fast and Frugal' (bottom).

6.3. Introducing Exogenous Events

As the experiments with the empirically based mix of voter decisions strategies demonstrate, our model is not yet able to replicate the election results of 2017, where the ÖVP emerged as the largest party winning 31.5% of the votes, while SPÖ (26.9%) and FPÖ (26%) came in close together as second and third. This is not particularly surprising, given that voters and parties do not exist in a vacuum only concerned with themselves or each other but are influenced by events happening in the world around them. It is therefore necessary to take extraneous influences into account. The events deemed most influential during the period 2013 to 2017 that we are covering with the simulation are the refugee crisis of 2015/16 and the leadership change in the ÖVP shortly before the election in 2017.

As mentioned at the end of Section 4, the new leader emphasised the topic of immigration above all else. Consequently, we represent this change in leadership by adapting the most important issues of the ÖVP accordingly at the correct time during the simulation. With the modified 'Aggregator' strategy this has the effect that the ÖVP will then start moving on the 'immigration' issue in addition to the 'economy' and 'spend vs. taxes' issues.

In addition to this one-time event, the model now incorporates the changes in issue salience in the public opinion over time as described in Section 5.3. The model keeps track of the currently 'valid' salience values for the seven issues and changes them at the pre-determined points in simulation time (defined by the dates in the EuroBarometer data) to the new values for the next period. These values are applied as probabilities whenever two voters interact and decide which topic to talk about. This mechanism replaces the ones used in the two different opinion formation processes (see Section 5.2.).

We undertook experiments with the empirically based mix of voter decision strategies and both model versions: Model A (default opinion formation process) and Model B (opinion formation based on Baldassarri & Bearman 2007). Due to the technical difficulties with Model B, we only ran scenarios with a subset of the voters (up to 500 randomly selected from the total pool of 3266). Results from these experiments with both model versions have so far been mostly unsatisfactory; there is no noticeable influence of these adaptations on model results. This confirms that using the different issue saliences to determine what people talk about is not enough. Voters not only have to talk about salient issues but react to these interactions by adapting their views on what they personally deem most important and how much emphasis they put on which of these issues.

Since the leadership change in the ÖVP happened so close to the election in 2017 and thus nearly at the end of a simulation run, we tried a finer resolution of simulation time (one step representing one week instead of two weeks) to allow all actors more time to react. Experiments with Model B then proved slightly more promising as the leadership change becomes at least visible albeit not to the correct degree (see Figure 11).

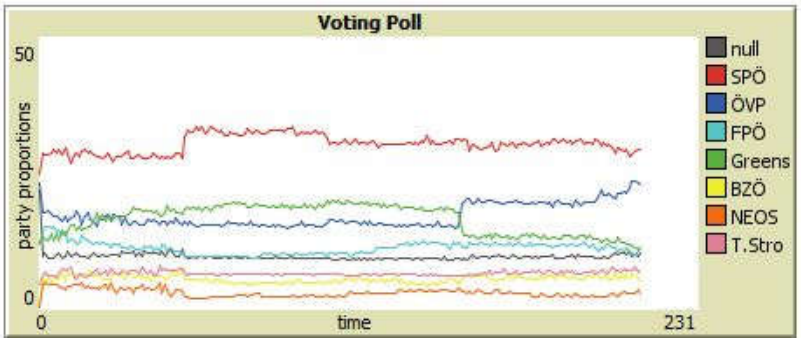

Figure 11: Evolution of vote shares with Model B (500 voters). The ÖVP leadership change at time 189 with subsequent change of the party's strategy results in a sudden gain of votes.

One possible way forward is to introduce ideal positions for parties, defining where the party wants to head in the policy issue space. The 'Aggregator' strategy can then be adapted to pursue a path weighing its supporters' positions against the party's own ideological ideal positions as suggested by Laver and Sergenti (2012, 214).

7. Conclusions

The aim of our first two years was to develop an ABM designed to help us understand the growth and broad appeal of populist parties in Western democracies. The value added in this case was to develop a strategy that deviates from typical quantitative political science research in hopes of integrating different input data from different levels of analysis and integrate different units of analysis such as parties and voters. Primarily, we wanted to test the feasibility of applying agent-based modelling to the research of voting behaviour, especially to study the impact of populism and use this information to model if-then scenarios based in part on changing the context factors. This is seen as an important step in the development of counter strategies.

To develop a final model as the basis for examining the dynamic relationship between parties and voters, we selected a well-documented reference case, in this case Austria, with a long-established history of populism. Using this case, which we understand well, we devolved a behavioural model for the key political actors for which cross-national survey data are available in standardized and thus comparable form. The behaviour decision strategies derived from the political simulation literature are configured such that the types would apply to all cases in the project and are both consistent and plausible with ABM theory and political science theory. Summing up, the application of agent-based modelling to the understanding of populist politics is innovative. To dig down into the processes behind populism to increase our understanding of these and then to test possible outcomes for different kinds of policy or political intervention remains the central objective. While our work has succeeded in identifying the relevant mechanisms and suggests a modelling strategy that can encompass our European cases, more work needs to be done to model input factors and contextual changes.

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