Modeling Political Individuals Using the Agent-Based Approach: A Preliminary Case Study on Political Experts and Their Limited Influence within Communication Networks

Frank C.S. Liu*

Institute of Political Science

National Sun Yat-Sen University

Kaohsiung 804, Taiwan

csliu@mail.nsysu.edu.tw

Received 8 July 2008; Revised 9 December 2008 ; Accepted 10 December 2008

Abstract. Agent-based modeling (ABM) has become a promising research approach in the social sciences, including economics and political science. ABM allows researchers to explore what-if questions that are not easily answered in the empirical world. As an attempt to advance cooperation between information professionals and social scientists to explore social inquiries, this paper introduces and details the design of S-RAS, an agent-based model originated from the literature of voting behavior. This paper further demonstrates an example of applying S-RAS to studying the role of political experts within communication networks. Studies in political science have identified that political experts play an important role in shaping their followers' views. Conventional wisdom suggests that citizens in a democracy who are embedded in heterogeneous networks where they perceive a significant level of disagreement are likely to be politically tolerant. While the study of communication networks helps advance our undersanding about the foundation of democracy, it is worth extending this stream of research to ask whether the increase in the number of political experts within communication networks have meaningful effect on the pattern of preference distribution. Three experiments were conducted. Findings, implications and limits of this study, and cross-disciplinary cooperation are discussed.

Keywords: heterogeneity, the Receive-Accept-Sample (RAS) model, agent-based modeling (ABM), communication networks, political experts

1 Introduction

Agent-based modeling (ABM, also known as multiple-agent simulation or individual-based modeling) has been introduced to a variety of disciplines, such aslike economics, business management, political science, and anthropology. This approach is primarily used to answer theory-oriented questions and address the effect of certain hypothesized conditions on the emer-gence of phenomena of interest. In other words, ABM is an approach to finding answers to what-if questions, which are difficult to answer using conventional empirical data analysis.

In object-oriented computing languages such as C++, JAVA and Objective-C, an "agent" is an object that contains rules and parameter values by which the object take actions that make sense to researchers. Like ecologists using a fish tank or a pond to simulate the ecological system of a water body, social scientists create agents as an alternative way to study the complexity of society. To political scientists using ABM, individuals and institutes, such as social groups, corporations, tribes, and countries, behave based on certain rules and patterns.

This paper elaborates the design of an agent-based model that integrates three important types of actors in political science: the news media, ordinary citizens, and political experts.[1] The case chosen for applying this model is the effect of political experts when the effects of the news media are considered. Specifically, this is a question that concerns political scientists, particularly students of communication networks, but is difficult to answer with conventional empirical data analysis: What would happen to the number of individuals perceiving diversity within communication networks when the number of political experts increases during a campaign season?

This case study is expected to interest both political scientists and modeling professionals. First, political science literature has been suggesting that political experts within communication networks shape the preferences of voters [10, 11, 12]. Public opinion is not simply the aggregation of individual preferences, but is shaped by

* Correspondence author

[1] Note that there exist a good number of applying ABM to study political subjects, such as social segregation [1], international relationships [2], party politics [3], and identification and social conflict [3, 4, 5, 6, 7, 8, 9]. For an overview of previous models on public opinion, see [9].

individuals' own preferences plus information obtained from the news media and those influential within communication networks. Hence, it is expected that when the number of political expert increases, the aggregated individuals' preferences will change.

By definition, communication network in this paper refers to family members, close friends, or those with whom we like to discuss politics daily. Furthermore, "political experts" are politically aware individuals; "political experts within communication networks" refer to trusted (or like-minded) family members, close friends, and/or colleagues in work places who we see politically knowledgeable and reachable. These network members are modeled as agents that exchange preferences and update their preferences automatically.

Second, the case chosen for study is expected to be a tutorial that demonstrates to readers how to model interdisciplinary applications with ABM. Political scientist John Zaller's theory that addresses how human beings process political information provides a solid, although insufficient, theoretical basis for constructing behavioral rules for citizen agents. To focus on the tutorial part, the next section will describe the design of an internally valid ABM model. The third section will describe modeling strategy–the initial settings and the arrangement for three experiments. The fourth section will report the results of a series of simulations. The last section will discuss the implications of the findings, the limits of the model, and topics for future research.

2 The Design of the S-RAS Model

The Swarm-RAS (S-RAS) model is a Swarm version of John Zaller's receive-acceptancesample (RAS) theory of voter preference (also called the RAS model or the RAS theoretical framework) [13].[2] The design of S-RAS follows the axioms in RAS, making it possible to study the interactions between multiple types of agents processing information in an R-A-S fashion. Fig. 1 illustrates the procedure of modeling political individuals. The arrangement of the following sections follows this flow of thinking.

This diagram suggests that the whole procedure of modeling political phenomena is composed of three loops of efforts: the loop of internal validation, the loop of external validation, and the loop of updating software. As there is no need to complete all of the loops in one research study, this paper focuses on the loop of internal validation, emphasizing that variables and behavioral rules be drawn from theories.

2.1 The Rules for Agent Information Processing

As a well-received and commonly cited theoretical model in political science, John Zaller's RAS model provides clear axioms about how individuals process political information: reception, resistance, accessibility, and sampling. The reception axiom (Axiom 1) states that political experts are aware of political issues and are more likely to acquire political information actively. The level of their political awareness (measured by political knowledge) determines the probability of obtaining political information.

The resistance axiom (Axiom 2) indicates that the awareness of political information determines one's propensity to reject incoming political information. Individuals tend to relate an issue to their political predisposition; political experts are more likely and capable than ordinary citizens to resist incoming political information. Specifically, political experts who are better-informed tend to resist information they encounter, whereas the majority of voters who are poorly informed tend to accept whatever information they encounter.

The last two axioms account for how individuals access obtained information and form their preferences. The accessibility axiom (Axiom 3) attests that individuals recall messages off the top of their head or base their statement of preference on information recently stored in memory. The response axiom (Axiom 4) testifies that individuals sample the stored messages to form their attitudes by "averaging across the considerations that are immediately salient or accessible to them" [13, p. 49].[3]

[2] Swarm is one promising ABM tool-kit that is free to download at http://www.swarm.org. While Swarm is written in Objective-C, an alternative package to Swarm that uses Java is Repast (http://repast. sourceforge.net/). S-RAS is a Swarm-based program, written in Objective-C; future efforts to translate SRAS to Repast are encouraged.

[3] This last axiom is based on a psychology model that emphasizes that the current impression about one thing is an average of stored impressions. The alternative model is online information processing, or the online-based model. In the online-based model, people use a "judgment operator" to continuously update their attitudes as they acquire new information: "They store the updated attitudes in memory and retrieve them in a given situation, including interview situations" [13, p. 50]. Zaller admits that neither the memory-based model nor the online model describes all cases; instead, it depends on the level of the issue and the availability of information in memory [13, p. 279]. (For more discussion about the differences between the memory-based model and the on-line model, see [14]).

The above axioms suggest that individuals follow the receive (Axiom 1)-accept (Axiom 3)-sample (Axiom4) procedure to form their preferences about a political issue or candidate.[4]

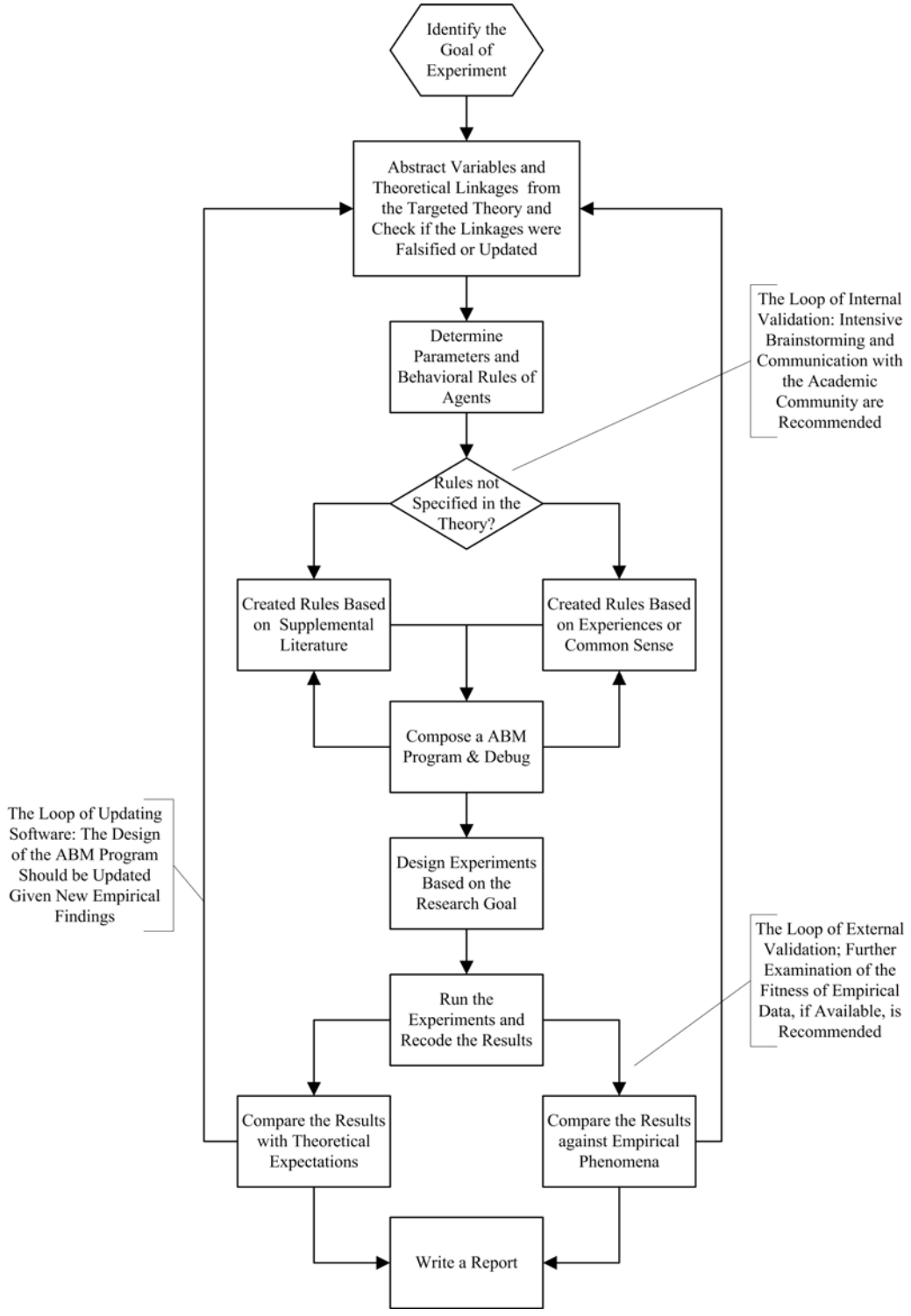


Fig. 1. The diagram of modeling political phenomena

[4] Axioms 1 and 2 are empirically supported. Zaller examines empirical data and finds that the reception of political information is a function of political awareness and that the resistance to political information is a joint function of political awareness and predispositions. However, it remains unclear whether individuals resist infor-mation before they receive it and whether individuals will process information in the order of Axiom 1 and Axiom 2. Therefore, as to be detailed later, this resistance axiom is incorporated into S-RAS in a less explicit fashion.

2.2 Variables in RAS and Parameters in S-RAS

Given a basic understanding of RAS, the next task is transforming the above concepts and axioms into S-RAS. The axioms provide general relations between variables derived from the theory, while parameters the variables operationalized with clear measurements.

There are seven variables that can be identified in RAS and will be called parameters in S-RAS: partisanship, voter preference, opinion, political expertise, propensity to access the news media, propensity to discuss politics, and propensity to perform selective perception.

An agent's partisanship by design is immutable, while voter preference as a function of the moving average of opinion presumably varies. (The relationship between opinion and voter preference is a critical part of model design and will be fully discussed in the next subsection.) Partisanship in S-RAS corresponds to the variable "political predisposition" in RAS. An agent's partisanship, denoted by 0 or 1, means its identification with Party 0 or Party 1 in a two-party system. Agents of partisanship "0" will be initiated with opinion favoring candidate of Party 0 (and, of course, will have a voter preference of "0"). These agents would also like to find discussants with "0" identification, and when performing selective perception (i.e., resisting incoming information from the media or reinterpreting information from the news media to be consistent with their partisanship, see [15]) will (re)interpret and save received message as "0." The same rules apply to those of partisanship "1."

The parameter political expertise refers to an agent's political knowledge, the concept positively related to the level of political awareness in Axiom 1. In S-RAS, every citizen agent has a randomly assigned value of political expertise, ranging from 1 to 10. Political expert agents have a higher value in this parameter than ordinary citizen agents.[5] According to the literature, political experts are more likely to access the news media, discuss politics with others, and to reinterpret information to be congruent with partisanship. Hence, in S-RAS those with higher values in political expertise have higher values in propensity to access the news media, propensity to discuss politics, and propensity to perform selective perception. (These propensities are denoted by values between 0 and 1.)

2.3 The Design of Preference Formation in S-RAS

Fig. 2 summarizes how citizen agents in S-RAS, including both political experts and ordinary citizens, acquire information and process received messages. In each time step agents complete a loop of action, from whether accessing a news media object to updating their voter preferences.

As the top of the figure shows, agents in S-RAS are initiated with a party identification, an opinion about candidates, a voter preference, and a favorite media object. They are concerned with one issue during an election season, such as a choice between two candidates of two political parties.[6] Specifically, every agent has an Opinion, a continuous variable with value drawn from a normal distribution and varying between 0.00 and 1.00. The opinion of agents who favor "0" is a random value drawn from a normal distribution bound between 0 and 0.5; the opinion of agents who favor "1" is also a random value drawn from a normal distribution but bounded between 0.5 and 1.0; and, agents who are ambivalent about candidates are assigned a 0.5 regarding their opinions.

Opinion is an agent's true preference, implicit to other agents and dynamically changing running tally. Just as when individuals discuss politics, individuals never know exactly the degree to which the discussant favors a candidate, but it is usually the case that they know the discussant's general impression of the candidate. Hence, by design, agents in S-RAS store their discussants' voter preferences instead of opinion. For example, if an ordinary citizen agent X is initiated with partisanship 1 and its current opinion is 0.6, its network members that interact with X at this time step will obtain "1." Similarly, if a political expert agent Y is initiated with Partisanship 0 and its current opinion 0.3, the member of its network that interacts with Y at that time step will record 0, instead of 0.3, in its runny tally of impressions.

Agents update their voter preferences based on their opinions.[7] Opinion 0.5 is the threshold of switching voter preference from 1 to 0 orfrom0 to 1. If an agent's partisanship is0 and its opinion rises above 0.5, its voter pref-

[5] Conventional wisdom in political science holds that the level of an individual's political knowledge is usually stable over time, while voter preference is an externalized message or impression that the agent is able to express and that the agent's discussants can easily perceive when they meet. When two agents meet, they obtain each other's voter preference and store it as a message in their stable over time. It is expected that the knowledge gap between information haves and have-nots will not be narrowed in the long run [10, 16]. Hence, although it is arguable that if the number of political experts were to increase during a campaign season, an assumption held in S-RAS is that the level of an agent's political expertise would remain stable throughout a simulation period.

[6] This implies that this version of S-RAS is limited to regions of a two-party system; countries of multiple political parties or campaigns with more than two candidates or issues are beyond the scope of S-RAS and this paper.

[7] This design of voter preference change is consistent with idea of autoregressive influence [6] and conformity to the majority (e.g., [6, 17]). The concept of autoregressive influence refers to the influence of perceived external pressure, including peer pressure. Such social influence "depends on the distribution of opinion across all other individuals within the network

erence will become 1; if an agent's partisanship is 1 and its opinion drops below 0.5, its voter preference will become 0; and if an agent's opinion becomes exactly 0.5, its voter preference will remain unchanged at that time step.

If agent X finds a political expert Y whose voter preference is 0, then X's string of voter preference will be updated from (1, 1, 1, 0, 0, 1, 1, 0, 1, 0) to (1, 1, 0, 0, 1, 1, 0, 1, 0, 0), given the far-most 1 is dropped and the new value 0 is added to the end of the string, then its updated opinion will become 0.5 and its voter preference will remain 1. If X continues to find Y and spends time with Y, X's opinion will become the average of (1, 0, 0, 1, 1, 0, 1, 0, 0, 0), 0.4, and its voter preference will be updated to 0.

An agent's updated opinion, as Axioms 3 and 4 of RAS suggest, is a moving average of voter preferences (1 or 0), of its own, of other agents, and of the news media. Axiom 4 indicates that an agent updates its opinion by a moving average function, calculated as D/(C+D), where D denotes the number of dominant message (i.e., messages that are more intense during the period of attitude change), and C denotes the number of countervailing messages (i.e., the less intense messages). The denominator (C+D) is an agent's memory capacity or capacity to store messages, which is a running tally storing incoming messages. To be detailed in the next subsection, an ordinary citizen agent stores 10 messages while a political expert agent stores 20 messages.

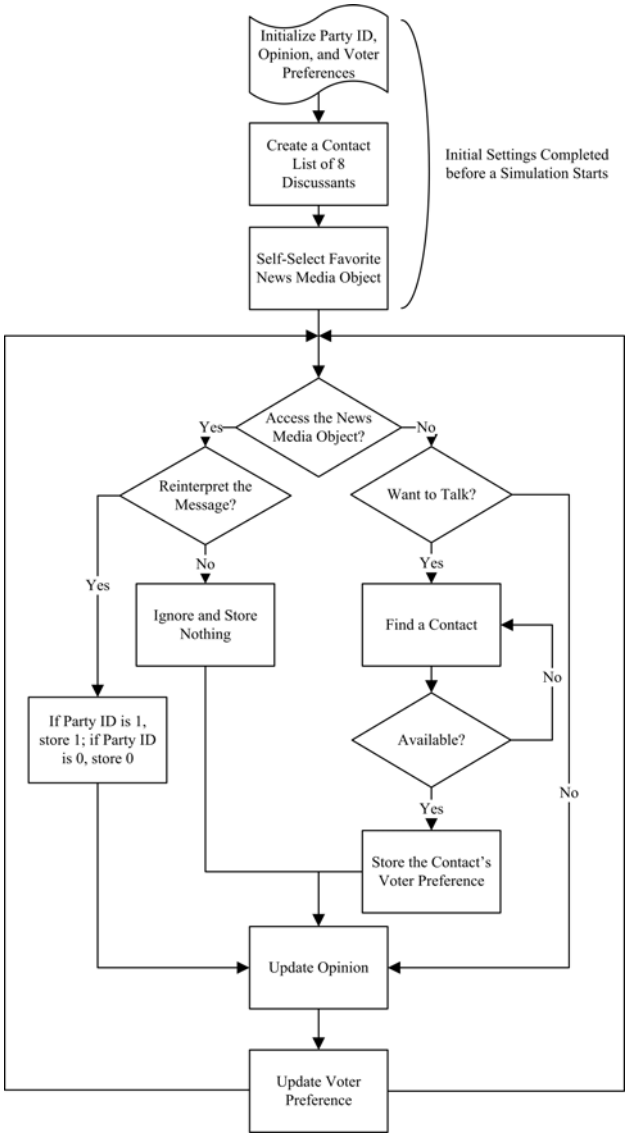


Fig. 2. The flow chart of R-A-S information processing

who are also connected to the first individual" [18]; in other words, when individuals perceive that messages from their social context turn to oppose their current preferences, they are likely to conform to the majority.

Table 1. The differences between political experts and ordinary citizens

	Political Experts	Ordinary Citizens
Political Expertise	[6, 10]	[1, 5]
Propensity to Access the News Media	[.6, .9]	[.1, .5]
Propensity to Discuss Politics	[.6, .9]	[.1, .5]
Propensity to Selective Perception	[.6, .9]	[.1, .5]
Capacity to Store Messages	20	10
Initial Opinion	[0, .5] or [.5, 1]	[0, .5] or [.5, 1]

2.4 Individual Differences

S-RAS addresses differences between individual agents by considering general distinction be-tween political experts and ordinary citizens [19, 10, 20, 21] and interpersonal differences within each type, including the propensity to access the news media, discuss politics, and perform selective perception and the capacity to remember political information [15].

Table 1 summarizes the characteristics of the two types of agents in S-RAS: political experts and ordinary citizens. The number in the brackets indicates the boundary for a normal distribution from which a random value is drawn. For example, that the propensity to discuss politics varies from 0.6 to 0.9 means that S-RAS will draw a random number for an agent as its value of propensity to discuss politics from a normal distribution bounded between 0.6 and 0.9. When the simulation starts, every political expert agent will have its unique propensity to discuss politics.

As compared to ordinary citizen agents, political expert agents in general, have a higher level of political expertise and are more likely to access the news media, to discuss politics, and to perform selective perception. Additionally, a political expert has greater capacity to store messages; it bases its opinion on the 20 most recent impressions (1s or 0s) stored in its memory, while an ordinary citizen's opinion is based on the 10 most recent impressions it collects.

2.5 The Context of Political Information

The context of political information for each agent in S-RAS include self-selected network members and self-selected news media. As Fig. 2 shows, an agent is initiated with its own traits and a contact list. This list is composed of eight neighbor agents. The opinions of this agent and its eight surrounding contacts are illustrated on a 3*3 grid (Moore neighborhood). The eight network neighbors are ordered by partisanship and political expertise. Specifically, an agent orders its contacts by (1) separating the contacts into two groups and prioritizing the group of like-minded contacts, i.e., sharing the same party identification, and then (2) within each group ordering those whose political knowledge is higher than the agent itself. Before a simulation starts, each agent will have a priority list, at the top of which is the most knowledgeable like-minded contact and at the bottom of which is the least knowledgeable agent that supports the opposite political party.

By this rule, political experts within an agent's communication network will be more frequently contacted than those less politically knowledgeable. As one would expect, the influence of political experts within communication networks on simulation results will be more prominent than alternative model designs that relax this selection rule.

Even though neighbors listed at the top of an agent's contact list are supposed to be the most frequently contacted, this does not imply that political experts should be contacted by the same agent. A political expert that is regarded as the most politically knowldegeable in its own network will be sought for discussion by its neighbors at almost every time step. Hence, it can be contacted by one at this time step but by another at the next time step, so on and so forth.

By design, every agent discusses politics with one other agent at a time step. Like human interaction communication, either face to face or using tele-communication, political discussion between agents is designed to be dyadic in fashion [22]. When an agent finds an available discussant, both agents will become unavailable to the other agents. If political experts in the neighborhood are not available, it will follow a loop and continue to find a person in this time step. Like a person discusses politics face-to-face with his best friend at a bar or exchanges political preferences with his wife via e-mail, an agent interacts with only one agent at one time, but it will be available for other contacts immediately after this time step. This design guarentees that no agent will be occupied by the same contact throughout the simulation and that no agents, particularly those low in political knowledge will be forced to be contacted, unless they want to.

Agents also identify favorite news media from which they receive evaluations about a candidate that are consistent with their partisanship. Note that S-RAS assumes that agents habitually check out news media reports

before finding someone to discuss politics [23]. For every "time step" or iteration during the simulation, every agent finishes its own loop of processing political information, including accessing the news media, discussing politics, or doing nothing if no discussant is available.

A news media object in S-RAS refers to any source of information other than dyadic interpersonal discussion. From this definition, the concept of news media will be extended to include political elites who usually appear on TV, newspapers, the Internet, and other kinds of news channels.[8] A news media object consistently holds a consistent voter preference, either 1 or 0. Unlike political discussant agents that may be unavailable sometimes, the news media objects can be accessed by any agent at any time. Hence, the two news sources can be seen as politically polarized media groups and the 9th network member that is always at the top of the contact list and is always available.[9]

In sum, the key point of the model design described above is that agents are selective about political information. Because agents are selective in choosing news sources and discussants, one should expect a pattern that most agents hold their voter preferences constant. This is the environment the experiment is about to employ to examine the extent to which the increase of the number of political experts changes this pattern.

3 Experimental Design

The above sections outline how the S-RAS model originated from the RAS model. This section will describe how it was used to examine the relationship between the increase in the proportion of political experts and the proportion of agents perceiving heterogeneity in their communication networks. To hold everything equal and then study the influence of the increase in the proportion of political experts, I conducted three experiments, setting the proportions of political experts to 0.02, 0.1, and 0.5, labeled Experiment 1, Experiment 2, and Experiment 3, respectively. Each experiment was run 100 times using different random seeds to generate agents.[10] Each iteration of the simulation is initiated with 1,600 agents allocated onto a 40*40 grid. Hence, each experiment will result in 100 data sets for statistical analysis.

Given the information drawn from the simulation results, such as the averaged proportion of agents perceiving at the end of a simulation, the (null) effect of stimulus can be found through a comparison across the results of the three experiments under the same settings: The citizen agents, including political experts and ordinary citizens, are divided regarding their voter preferences, i.e, 50% of ordinary citizens support "Yes" or 1, while the other 50% support "No" or 0. Similarly, political experts are also polarized in their preference regardless of the proportion change of this type of agents.

Because of the specific settings of a polarized society in S-RAS, it is reasonable to expect that, when the proportion of political expert increases, the simulated society will remain polarized overtime. However, since all agents are unique and all actors act and process information independently and simultaneously, it is not clear at this stage whether one can expect any in-formation or explicit patterns to emerge from continuous interactions among agents and their political contexts [24]. It is also important to keep in mind that, due to these settings of a polarized society, the simulation results and their interpretation should be confounded within this scope.

4 Results

A simulation, once started, continues to fun unless the system indicates that all agents' voter preferences become stable (i.e., no agent whose opinion value changes between a value above 0.5 and a value below 0.5 in any two consecutive iterations for 20 run times). I arbitrarily set the simulation to stop at the 900th run time because a polarized society appears in a campaign season, a relatively short-term period. It would make less sense to as-

[8] Zaller suggests that the news media and political elites are one information source entity, which means that (1) political elites usually exert their influence through TV, newspapers, radio, etc., and (2) the news media, in effect, exerts their influence by reporting about the words and activities of political elites. Following this perspective, S-RAS labeled this media-elite entity as "the media" and focuses on the role of political experts.

[9] It is important to note that the news media objects, although I label them as "the news media," are not simply two TV stations or channels. They can include a TV channel, a newspaper, a radio program, a magazine, a news Website on the Internet, or even a town hall meeting. Because the attention is placed on what an individual agent actually receives, there is no need to create objects representing every specific type of public or private news source.

[10] All of the random numbers used are created from different "seeds". The initial settings of the models using the same seed will be the same so that a certain simulation can be replicated. Since the purpose of this project is to run the same experiment 100 times so as to differentiate initial settings, it is important to use different seeds for each run. To do so, S-RAS uses seeds that are based on the system clock.

sume a never-ending polarized situation and run simulations much longer, even though a later experiment confirmed that the results and the patterns did not change if the same simulations were run for 2,000th iterations.

Table 2. Summary statistics of 100 runs of the simulation for each experiment

Proportion of Agents	Experiments (% Political Experts)					
	Exp 1 (2%)		Exp 2 (10%)		Exp 3 (50%)	
	mean	(s.d.)	mean	(s.d.)	mean	(s.d.)
Perceiving Diversity	0.500	(0.007)	0.499	(0.007)	0.500	(0.007)
Preference "Yes"	0.501	(0.011)	0.501	(0.011)	0.499	(0.012)
Preference Changed	0.005	(0.002)	0.005	(0.002)	0.002	(0.003)
Bolstered Minority	0.326	(0.016)	0.326	(0.017)	0.328	(0.018)

Table 2 presents the summary statistics of the series of simulations, including the means and the standard deviations (s.d.s) of the results over the 100 runs of the simulations. The means indicate the average value of the results, while the standard deviations indicate the variation of the means. The overall low standard deviations suggest that the results derived from the 100 simulations are stable.

S-RAS collected four dimensions of information that help monitor the emergence of patterns. The first is perceiving diversity. Every agent at each time step reports the proportion of agents holding the opposite voter preference. Perceiving diversity is the average of this proportion across the 1,600 agents. This figure indicates the proportion of agents that are perceived as non-like-minded discussants within networks. As the results across the three experiments show in Table 2, the increase of political experts within communication networks has little impact on perceiving diversity. The original division of society was not changed at all in the three experiments. A polarized society, polarized news media, and polarized political experts seem to function together to inflate or offset the influence of expert increase.

This continuum of the polarized society is also suggested by the second and the third aspects of observation: the proportion of agents supporting preference "1" and the proportion of agents changing their voter preferences. The former remains consistently around 50% across the three experiments. The latter indicates few agents (less than 0.5% of the population) changed their voter preferences when the simulations stopped. This pattern further implies that, even though most agents adjust their opinions dynamically, as most political scienece literature suggests, individuals' voter preferences remain stable over time.

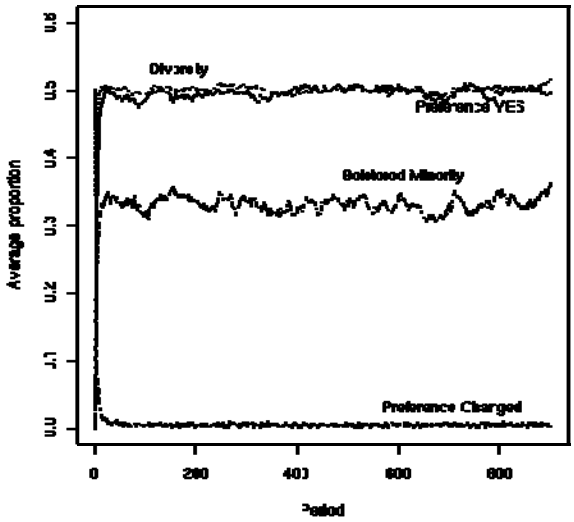
One other aspect to capture this phenomenon is bolstered minority, the fraction of agents that are recorded as supporting the minority within their networks. An agent is recorded as having a bolstered minority if it has exactly one, two, or three network members (out of the eight neighbors) whose voter preferences are the same as the agent's; this agent will not be recorded as a "minority" any longer if the number of supportive contacts exceeds three.

Recall that an agent's voter preference will switch if its opinion passes the threshold of 0.5. Although an agent may selectively seeks political messages that are consistent with its partisanship from the news media, when the majority of its network members are favoring a candidate from the opposite political party, the agent is expected to be gradually influenced by the majority through dyadic interaction. Its voter preference will eventually change. Hence, this figure indicates the proportion of agents that are likely to be immune from the conformity effect. As the last row in Table 2 suggests, about one-third of the agents are part of this kind of communication networks where the minority voters remain resistant to the influence from the majority.

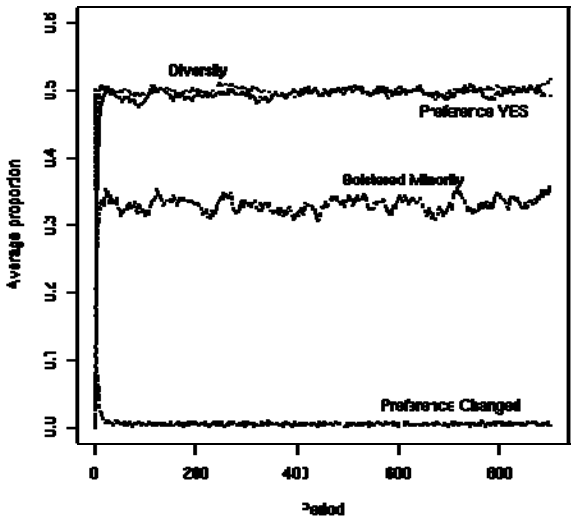
The graphs shown in Fig. 3, consistent with the previous descriptive statistics, further shows the dynamics and the magnitude of changes in the figures regarding the above four dimentions. As the standard deviations shown in Table 2 are small, a graph randomly chosen from the 100 runs should be representative of the results of the other 99 simulations.

The curves for "Diversity," " Preference YES," and "Preference Changed" shown in graphs (b) and (c) are very like those in graph (a). They are not straight lines but are very stable curves fluctuating around 0.5. This pattern confirms the previously mentioned pattern that, even though all agents like to access political experts for information, the increase in the number of political experts has little leverage to (1) increase the level of dynamics in the process of preference aggregation and (2) expand the number of individuals perceiving preference diversity. Note that the curve "Bolstered Minority" in graph (c) shows a high level of dynamics in the first 200 iterations. This dramatic dynamics smooths out, however, when the simulation runs toward the end.

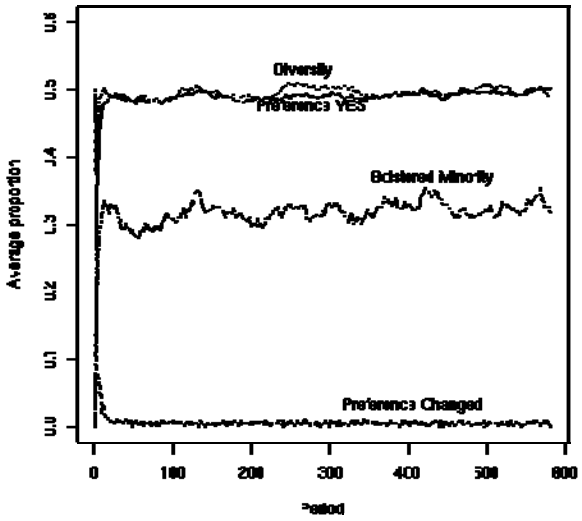
ABM allows researchers to attribute the causes of a pattern derived from a simulation to model design. Since this stable pattern cannot be attributed to the changes in the proportion of political experts within communication networks, the preservation of disagreement within communication networks is attributed to (1) the introduction of the news media effect, the design that allows agents to access congruent political messages from outside communication networks and (2) the supportive network members by which a minority agent stand against the influence of the majority.



(a) Experiment 1: The Proportion of Political Experts = 2%



(b) Experiment 2: The Proportion of Political Experts = 10%



(c) Experiment 3: The Proportion of Political Experts = 50%
Note: in this run of simulation the model stopped automatically at the 593rd iteration.

Fig. 3. The time-series graphs of the three experiments

5 Conclusion and Discussion

Recent reflection on the development of ABM suggests that the design of an agent-based model should not completely be based on researchers' imagination or over-simplified rules; a good design is expected to be rooted in sound theories, empirical findings, or, ultimately, both. Internal validity–whether or not the behavioral rules and environmental settings of a model make sense, determines the extent to which the simulation results can be correctly understood and interpreted [25, 26, 27]. It is more important today that an internally valid model has consensus from members of the associated academic community [28, 29].

This paper is one of few attempts that seek "consensus from members of the associated academic community" by opening up considerations and assumptions underlying the model's design. Indeed, the not-so-exciting findings of this study are not supposed to be an ideal example or template for sophisticated political research. Sufficient room is left for future modeling works to advance the design of S-RAS or apply it to finding more stable and interesting patterns about public preferences.

It has been commonly held that a society with freedom of speech and diverse preferences help to cultivate a deliberative and politically tolerant society. In this process of civilization, scholars have been thinking that political experts play the role of shaping voter preferences and expecting that the increase in the number of political experts will help to leverage preference diversity and then increase the number of individuals perceiving heterogeneity within communication networks.

This paper introduces S-RAS, an agent-based simulation program based on John Zaller's RAS model, and applies it to test this scenario. The laboratory experiment's preliminary results suggest that an increase in the proportion of polarized political experts would neither stimulate more dynamic changes in the process of voter preference aggregation nor cultivate more citizens that perceive political disagreement.

While this finding may contradict the conventional, optimistic view about the role of political experts, the simulation results of this paper do not stand alone. Recent research does suggest that the news media and political elites (i.e., government leaders, journalists, and the like) will have a limited effect on the process of public preference formation when individuals' political discussion concerns conflicting perspectives [30]. This paper furthers this perspective by asserting that a polarized society where the two sides of perspectives are almost equally distributed across the electorate is a critical factor that weakens the effect of political experts on the number of ordinary citizens perceiving diverse preferences.

Besides the settings about polarized phenomena, one more explanation for this null-finding is that the influence of self-selected news media may outweigh the effect of political expert. As Fig. 2 has shown, all agents think about accessing the news media before thinking about accessing political experts every time when taking the action of acquiring political information. In future research that continues to examine the minor effect of political experts, it will be necessary to examine whether (1) this assumption still holds empirically and (2) a reversal of the order (i.e., assuming individuals talk politics before accessing the news media) affects the result.

This paper provides computer scientists and ABM modelers access to current political science theories and empirical findings about voters. It is expected that greater elaboration on improving the design of S-RAS will help to advance the enterprise of voter studies and public opinion research.

Putting the contributions aside, there are a number of limitations of S-RAS to summarize. Inheriting ideas from Latane's model of dynamic social impact theory (DSIT), the SRAS model inevitably comes into some of the same limitations evident in DSIT, such as being overly-simple in model design, simultaneous actions in agent behavior, geographical constraints of contacts, and validation.

The first and most serious problem with DSIT is that it does not clarify how messages are passed and perceived between agents [31, p. 10]. For example, an individual may perceive messages on television differently than the agent would if the same message were seen on the Internet. In S-RAS, this problem has been partially solved by: (1) creating two types of agents with different propensities for accessing the news media and discussing politics; (2) following Zaller's RAS model to specify individuals' information processing process; and (3) making it possible for agents to store messages from trusted sources. Despite these issues, the S-RAS model, like DSIT, is still unable to explicate all of the subtle parts of interpersonal communication, such as information encoding and deciphering and selective retention [12].

The second limitation of the S-RAS model is that all agents take only one action–discussing politics, accessing the news media, or doing nothing at all–at any given run time. In the future, agents in the S-RAS model should be able to do more than one thing at one time, such as discussing politics with family members while watching television news or discussing politics with a group of friends at a bar.

S-RAS is constructed based on the practice of "cellular automata" [32], in which all citizen agents are located in geographically bound network. The artificial societies characterized by the three experiments of this paper are better seen as large networks composed of a number of smaller and overlapping 3*3 grids where agents are at the centers of their own grid. The third limitation of S-RAS, therefore, is geographical constraints of the agents. The number of a communication network is fixed to eight and agents do not change the size of their networks during the simulation. Researchers concerned with agents' ability of agents to move around and seek discussants

outside their geographically-bounded networks (e.g., [18]) should consider relaxing this assumption. Researchers concerned with the problem of overlapping communication networks may think about adding random white space to the grid.

The final concern about future revision or application of S-RAS is its external validity and (still) internal validity. Regarding external validity, one should be cautious about over-interpreting simulation results before S-RAS is further validated with empirical cases or data. Future researchers that apply S-RAS to voter preference studies need to pay great attention to whether and how simulation results correspond to a target system, what social reality a specified model represents, and what the difference between a model and a simulation will be. Regarding internal validity, the rules and assumptions used for S-RAS design can be updated, adjusted, or proved wrong tomorrow. Hence, it is important for future researchers using S-RAS to seek cross-disciplinary insights to advance this program and double check whether the assumptions used wit it remain acceptable for scholars across disciplines.

6 Acknowledgement

The author is thankful for financial support from National Science Foundation (NSC 96-2414-H-110-001) and useful comments from the two anonymous reviewers.

References

[1] T. C. Schelling, *Micromotives and Macrobehavior*, New York: Norton, 1978.

[2] D. M. Lustick, Ian S, and R. J. Eidelson, "Secessionism in multicultural states: Does sharing power prevent or encourage it?," *American Political Science Review*, Vol. 98, No. 2, pp. 209-229, 2004.

[3] M. Laver, "Policy and the dynamics of political competition," *American Political Science Review*, Vol. 99, No. 2, pp. 263-281, 2005.

[4] D. Rousseau and A. M. Van der Veen, "The emergence of a shared identity: An agent-based computer simulation of idea diffusion," *Journal of Conflict Resolution*, Vol. 49, No. 5, pp. 686-712, 2005.

[5] D. Rousseau, *Identifying Threats and Threatening Identities: The Social Construction of Realism and Liberalism*, Palo Alto, CA : Stanford University Press, 2007.

[6] R. Huckfeldt, P. E. Johnson, and J. D. Sprague, *Political Disagreement: The Survival of Diverse Opinions within Communication Networks*, New York: Cambridge University Press, 2004.

[7] P. Johnson, "Simulation modeling in political science," *American Behavioral Scientist*, Vol. 42, No. 10, pp. 1509-1530, 1999.

[8] B. Latane and A. Nowak, *Self-organizing social systems: Necessary and sufficient conditions for the emergence of clustering, consolidation, and continuing diversity*, Vol. 13, pp. 43–74, 1997.

[9] F. C. Liu, "Constrained opinion leader influence in an electoral campaign season: Revisiting the two-step flow theory with multi-agent simulation," *Advances in Complex Systems*, Vol. 10, pp. 233-250, June 2007.

[10] P. Converse, *The nature of belief systems in mass publics*, pp. 206-261. New York: New York: Free Press, 1964.

[11] J. N. Druckman, "Political preference formation: Competition, deliberation, and the (ir)relevance of framing effects," *American Political Science Review*, Vol. 98, pp. 671-686, Nov. 2004.

[12] J. T. Klapper, *The Effects of Mass Communication*, Glencoe, Ill.: Free Press, 1960.

[13] J. Zaller, *The nature and origins of mass opinion*, Cambridge England; New York, NY: Cambridge University Press, 1992.

[14] J. N. Druckman and A. Lupia, "Preference formation," *Annual Review of Political Science*, Vol. 3, pp. 1-24, 2000.

[15] M. B. Oliver, "Individual differences in media effects," *Media Effects: Advances in Theory and Research* (J. Bryant and D. Zillmann, eds.), pp. 507-524, 2002.

[16] J. Jerit, J. Barabas, and T. Bolsen, "Citizens, knowledge, and the information environment," *American Journal of Political Science*, Vol. 50, pp. 266-282, April 2006.

[17] W. R. Neuman, M. R. Just, and A. N. Crigler, *Common knowledge: News and the con-struction of political meaning*, Chicago: University of Chicago Press, 1992.

[18] R. Huckfeldt and J. M. Mendez, "Managing political heterogeneity: Perceptions of dis-agreement within communication networks," *Midwest Political Science Association 62nd Annual National Conference*, April 15-18, Chicago, IL, 2004.

[19] L. M. Bartels, "Unenlightened self-interest," *The American Prospect*, Vol. 15, No. 6, pp. A17-A19, 2004.

[20] P. Converse, "Popular representation and the distribution of information," *Information and Democratic Processes*, pp. 369-90, Urbana, IL: University of Illinois Press, 1990.

[21] M. P. Fiorina, S. J. Abrams, and J. Pope, *Culture War? The Myth of a Polarized America*, New York: Pearson Longman, 2005.

[22] R. Huckfeldt and J. D. Sprague, *Citizens, Politics, and Social Communication: Information and Influence in an Election Campaign*, Cambridge, England; New York: Cambridge University Press, 1995.

[23] D. C. Mutz and P. S. Martin, "Facilitating communication across lines of political difference: The role of mass media," *American Political Science Review*, Vol. 95, No. 1, pp. 97-114, 2001.

[24] J. M. Epstein and R. Axtell, *Growing Artificial Societies: Social Science from the Bottom Up*, Complex adaptive systems, Washington, D.C.: Cambridge, MA: The MIT Press, 1996.

[25] R. M. Entman and S. Herbst, "Reframing public opinion as we have known it," *Mediated Politics: Communication in the Future of Democracy* (W. L. Bennett and R. M. Entman, eds.), pp. 203-225, 2001.

[26] D. A. Graber and J. M. Smith, "Political communication faces the 21st century," *Journal of Communication*, Vol. 55, No. 3, pp. 479-507, 2005.

[27] J. S. Lansing, "Complex adaptive systems," *Annual Reviews of Anthropology*, Vol. 32, pp. 183-204, 2003.

[28] J. Becker, B. Niehaves, and K. Klose, "A framework for epistemological perspectives on simulation," *Journal of Artificial Societies and Social Simulation*, Vol. 8, No. 4, 2005.

[29] A. Schmid, "What is the truth of simulation?," *Journal of Artificial Societies and Social Simulatio*n, Vol. 8, No. 4, 2005.

[30] J. N. Druckman and K. R. Nelson, "Framing and deliberation: How citizens' conversations limit elite influence," *American Journal of Political Science*, Vol. 47, No. 4, pp. 729-745, 2003.

[31] E. Fink, "Dynamic social impact theory and the study of human communication," *Journal of Communications*, Vol. 46, No. 4, pp. 4-12, 1996.

[32] A. Nowak and M. Lewenstein, *Modeling Social Change with Cellular Automata*, Modeling and Simulation in the Social Sciences from a Philosophical Pint of View, Boston: Kluwer Academic Publishers, pp. 249-285, 1996.