Opinion Transmission in Organizations: An Agent-Based Modelling Approach

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AN AGENT-BASED MODELING APPROACH

Abstract

This paper builds a theoretical framework to detect the conditions under which social influence enables persistence of a shared opinion among members of an organization over time, despite membership turnover. It develops agent-based simulations of opinion evolution in an advice network, whereby opinion is defined in the broad sense of shared understandings on a matter that is relevant for an organization's activities, and on which members have some degree of discretion. We combine a micro-level model of social influence that builds on the "relative agreement" approach of Deffuant et al. (2002), and a macro-level structure of interactions that includes a flow of joiners and leavers and allows for criteria of advice tie formation derived from, and grounded in, the empirical literature on intra-organizational networks.

We provide computational evidence that persistence of opinions over time is possible in an organization with joiners and leavers, a result that depends on circumstances defined by mode of network tie formation (in particular, criteria for selection of advisors), individual attributes of agents (openness of newcomers to influence, as part of their socialization process), and time-related factors (turnover rate, which regulates the flow of entry and exit in the organization, and establishes a form of endogenous hierarchy based on length of stay). We explore the combined effects of these factors and discuss their implications.

Key Words

Social influence; Social networks; Intra-organizational networks; Agent-based modeling; Opinion dynamics.

INTRODUCTION

Opinions, defined as shared understandings on matters that are relevant for an organization's activities, and on which members have some degree of discretion, often display remarkable persistence in organizational contexts. Such persistence is intriguing if we consider the centrifugal forces, such as time and membership turnover, which may threaten the stability of any consensual outcome (Harrison & Carroll, 1991). Under the constant pressure of time and membership turnover, how can we explain that some opinions persist in organizations while in other cases, two or more opinions coexist in the same organization? It is thus important to elucidate the process of transmission of opinions over time and across cohorts, above and beyond the common understanding that it ultimately relies on social influence – namely the change in an individual's thoughts, opinions or behaviors that arises from interpersonal interactions (Rashotte, 2007).

In recent years, a growing body of research has endeavored to identify the conditions under which, over time, social influence taking place at micro (dyadic) level gives rise to macro patterns of transmission and diffusion through repeated iterations (Rousseau, 2011). These patterns differ depending on initial conditions (e.g., number of members, initial opinions), intensity of influence and modes of interaction, and may give rise to consensus around a single opinion, polarization between two opposing groups of opinion, or fragmentation into multiple, separate opinion clusters. Agent-based computer simulation has been extensively used to model dynamic processes in which consensus, polarization or fragmentation appear as emergent properties of the social system, owing to endogenous feedback effects arising from multiple, repeated interactions between individuals who influence one another. With heterogeneous populations, influences may spread from one subset of agents to others, under given conditions (Deffuant, 2006; Deffuant, Amblard, Weisbuch & Faure, 2002; Deffuant, Neau, Amblard & Weisbuch, 2001; Gargiulo & Mazzoni, 2008; Hegselmann & Krause, 2002; Jager & Amblard, 2004; Kułakowski, 2009; Malarz, Gronek & Kułakowski, 2011).

Agent-based simulation involves the generation of an artificial society to identify the conditions under which given factors suffice to produce some social phenomenon of interest – here, the possibility that an opinion is persistently shared in a group, even after the individuals who originated this opinion have left the group. The outcomes of the simulation enable to assess the

coherence and completeness of the description of the phenomenon and the initial assumptions – here, micro-level social influence. This approach does not exclude alternative representations of the same phenomenon, but provides a consistency test of the proposed interpretation of it (Epstein, 2006). A model thus requires a dual assessment (Gilbert & Troitzsch, 2005): that the micro-behavior is logically sound (see the discussion of Deffuant, Weisbuch, Amblard & Faure, 2003) and that the patterns that emerge are meaningful concerning the issue at stake (Grimm, Berger, Bastiansen, Eliassen, et al., 2006).

Within this literature, the "relative agreement" model of Deffuant et al. (2002), whose representation of opinion is capable of accounting for nuances and comprises a measure of openness to influence, has become a standard reference (Rouchier, 2013). Many researchers have re-used it for further analysis, developing variants and refinements (Fortunato, 2004; Jager & Amblard, 2004; Amblard & Deffuant, 2006; Kozma & Barrat, 2008, to name just a few). Even its terminology, using the term "opinion" to cover a wide range of behaviors and attitudes that can be subject to influence, has imposed itself, supplanting the older use of "culture" (Axelrod, 1997). So far, these models have mostly been applied to political issues such as societal cleavages and spread of extremisms (Rolfe, 2009). In this article, we endeavor to further extend Deffuant's model to allow purposeful application to organization studies.

Indeed, the results already obtained in previous research do not transfer easily to organizational settings, for two reasons. First, extant models ignore membership turnover, an important property of real-world organizations and a basic mechanism through which they evolve. In any given period, some members leave the organization while some newcomers join. Newcomers possibly bring with them new opinions, which may challenge any previously established opinion. Second, this literature represents the structure of interactions within which social influence takes place as sheer random matching, without considering more plausible relational forms. Yet literature on organizations points out that influence is most likely channeled through the internal network of communication, knowledge-sharing, and advice-seeking among members (Krackhardt & Hanson, 1993). Selection of advisors depends on criteria that are specific to organizational contexts, depending on both the formal structure of an organization (seniority levels for example) and informal factors

(perceived competency of members, inter-individual similarities), with potential consequences on the spread of opinions through social influence.

Our thought on these issues has been inspired by a real-world case study, mapping normative opinions and advice networks at the Commercial Court of Paris (Lazega & Mounier, 2003). A five-century old judicial institution in charge of a large number of commercial litigation and bankruptcy cases including some high-profile ones, the Court is an elected body, where members are not career magistrates but experienced businesspeople or top-level company managers whose mandates are for a fixed term of up to 14 years – thus implying a regular turnover, with joiners and leavers every year. In this setting, judges with more senior positions appeared to differ in their views (opinions) from more junior judges. When facing such a stylized fact in a complex system, two types of hypothesis can be made: (i) either judges learn, individually, what opinion is most useful in that context, and change their view over time; (ii) or there exists some form of social influence in the Court, so that the views of newcomers gradually converge towards the stance that is held at the top. We focus on this second hypothesis, aiming to establish the extent to which emergence and persistence of shared opinions within this institution could result from a collective learning process. Available empirical evidence supports this approach: indeed a dataset of the advice network of judges, collected at three points in time (2000, 2002 and 2005), reveals a correlation between network structure, formal hierarchy of the institution (in particular, its division into Chambers, annual rotation of members across Chambers, rules of attribution of senior management roles) and normative views, which could hardly result from random matching; Rouchier & Tubaro (2011) show that an agent-based simulation based on Deffuant's model and modified to include membership turnover, but still assuming randomness in the formation of inter-personal ties, does not fit the data well. Instead, other factors are found to play a role in network tie formation, notably seniority and the internal hierarchy of the institution, as well as homophily, including opinion homophily (Lazega, Lemercier & Mounier 2006; Lazega, Mounier & Tubaro 2011; Lazega, Mounier, Snijders & Tubaro 2012).

The present article abstracts from this particular empirical case to build a more universal approach, suitable to the study of organizations in general. We aim to offer a way forward to further applications to organizational contexts – a minimal model design which, however simple, is general

enough to authorize subsequent customization and adaptation to a wide range of organizational structures. Thus, we take out the specificities of the Paris Court (such as its division into Chambers, and annual Chamber rotation) to retain only the elements that the broad management and organizational literature confirms to be commonly found, notably turnover and the identification of key drivers of intra-organizational advice network tie formation. In this sense, we situate our work in the tradition of, among others, March (1991), Harrison and Carroll (1991) and Carroll and Harrison (1998), who all base their models on computer simulation, but derive their assumptions from established theoretical and empirical literature.

Our model is at a high level of abstraction, and is meant primarily to support theory generation (Epstein, 2006), so that it cannot be empirically tested as it is. Rather, we consider it as a first step in a long-run effort to develop a family of analytical tools that benefit from the insight accumulated in the agent-based literature, while offering a fit-for-purpose framework of analysis, and allowing sufficient flexibility for subsequent tailoring to specific organizational case studies (Amblard, Bommel & Rouchier, 2007). The model also contributes to agent-based modeling research per se because, to the best of our knowledge, it is the first to offer theoretical results on populations with entry and exit of members over time.

Along these lines, we adopt a deliberately simplified representation of opinion that leaves aside the specific contents that organization members discuss. In line with the agent-based modeling tradition, we interpret opinion in the broad sense of a shared understanding on a matter that is relevant for the organization's activities, and on which members have some degree of discretion. This definition stresses the potential durability of opinion and its possible acceptance by the whole membership, while allowing for minor variations at the individual level. We focus on how opinion can be transmitted from existing members to new ones, so as to be sustained in the long run, regardless of the views that newcomers may have held prior to joining.

OPINION TRANSMISSION IN ORGANIZATIONS

Understanding how opinions are transmitted in an organization from generation to generation requires uncovering the mechanisms of social influence among organizational members. Social

influence can flow through social networks (Salancik & Pfeffer, 1978; Rashotte, 2007; Friedkin, 1998). Within organizations, advice networks are particularly important channels for influence (e.g. Krackhardt & Hanson, 1993; McDonald & Westphal, 2003). An advice network is defined as "the pattern of relations among [organizational] members in which one member seeks advice from another member" (Athanassiou & Nigh, 1999: 86) and develops over time as organizational members seek assistance, guidance, information, and opportunities for problem solving (Gibbons, 2004). Advice networks have been studied to understand knowledge transmission (Reagans & McEvily, 2003), changes of organizational strategies (McDonald & Westphal, 2003), changes in attitude toward technology (Burkhardt, 1994) and status differentials (Lazega et al., 2012).

We build a framework under which social influence channeled by an advice network enables emergence of a shared opinion among members of an organization over time, despite membership turnover. By doing so, we extend the model of Deffuant et al. (2002). In light of extant management and organization literature, we discuss how three dimensions of advice networks contribute to driving opinion dynamics: selection of advisors, newcomers' openness to influence (which we call "latitude of acceptance", following Jager & Amblard, 2004), and turnover rate.

Effects of advisor selection

The first dimension is the advice network selection criterion adopted by individuals when seeking advice, knowledge, and information from others. We consider two criteria that can significantly impact opinion transmission in organizations through social influence mediated by advice ties: experience and homophily.

Experience. Individuals often seek advice from members who have been in the institution for a long time, especially when this is most likely to increase knowledge and expertise. Indeed, if people select advisors according to expected work-related input (i.e., they want competent persons) and if time spent in the organization increases competence at least in certain matters (e.g. knowing how things work internally, what procedures and rules to follow in different circumstances, who is

responsible for what task, etc.), then more senior people are likely to be more sought out for advice (Comer, 1991; Settoon & Adkins, 1997; Slaughter & Zickar, 2006).

If "individuals may change an opinion under the influence of another who is perceived to be an expert in the matter at hand" (Rashotte 2007: 4426), then advice from a supposedly expert more senior member transmits specialized information as well as attitudes, beliefs, and values to a non-expert (Hill & Carley, 2008; Morrison, 2002), and may modify the opinion of the latter. Along these lines, we model a tendency of agents to seek advice from more experienced colleagues, and to be potentially subject to influence by them.

Homophily. Individuals may also seek advice from those they know hold similar opinions, which is a way to represent value homophily. A large body of literature in social psychology suggests that similarity enhances friendship, the desire to provide social support (McDonald & Whestphal, 2003) and empathy (Westphal & Milton, 2000). In organizations, the work of Ibarra (1992) first revealed that similarities enhance relationships. Although there are several dimensions along which similarities may exist (gender, nationality, native language, educational background, etc.), we look only at one specific dimension, namely opinion or value similarity. Members sharing common values have an additional cognitive motivation for seeking advice from one another; they will more easily approach one another for advice (possibly lowering the effects of status); and they may trust advisors more. Advisors may be more willing to provide advice in order to gain support for their opinions (Centola, González-Avella, Eguíluz & San Miguel, 2007; Nahapiet & Ghoshal, 1998).

One may think that when mediated by homophilous ties, social influence will necessarily lead to formation of sub-groups, each with its own opinion and separate from others. However, the agent-based literature has shown that different outcomes are possible, all the more so in a system that evolves over time. Gargiulo and Mazzoni (2008) provide evidence that homophilous choices may allow for emergence of consensus, while Kozma and Barrat (2008) show that fragmentation may occur in static networks, but not in dynamic networks where homophily can only lead to consensus or

polarization. By including value-homophilous choice of advisors in our model with turnover, we aim to draw conclusions about the possibility to generalize these previous results.

We treat experience and homophily as two separate criteria for advisor selection in our system, and we also combine them in an effort to fit to a plausible representation of human choice, thereby increasing the credibility of the model. By so doing, we extend the effort undertaken in recent literature (Harrison & Carroll, 2002; Kozma & Barrat, 2008) to incorporate more realistic selection criteria in agent-based models, so as to overcome the simplifying, but unrealistic assumption that agents are equally likely to form ties with anyone else.

Effects of latitude of acceptance of newcomers

The process of social influence especially affects newcomers into an organization (Rice & Aydin, 1991; Schein, 2003; Bauer, Bodner, Erdongan, Truxillo & Tucker, 2007). Unsure of their role and apprehensive about their status, newcomers aim to build a situational definition (Schein, 2003). They seek information and advice through different communication channels (e.g., social interactions with supervisors and peers - Saks & Ashforth, 1997) to refine their understanding of the organization in terms of norms, opinions, policies, or power. They can thus "diagnose and interpret the many surprises they encounter" (Bauer et al., 2007: 709) and reduce the uncertainty surrounding their new organizational environment.

We therefore introduce a "latitude of acceptance" variable representing willingness to be influenced by others (or equivalently, lack of individual self-confidence). We allow latitude of acceptance to vary with time spent in an organization in order to account for the observed differences between newcomers and more senior organization members. Because of newcomers' need to reduce uncertainty, they are likely more open to social influence, while the extent to which they are ready to accept others' opinions diminishes over time, as they gain confidence and knowledge of the organizational environment in which they operate. While the latitude of acceptance always decreases with time spent in the organization, it may start from different initial levels depending on a variety of

external circumstances that affect newcomers' attitudes but are hardly under the control of the organization. We expect lower levels of initial acceptance (i.e., lower willingness to be influenced by others) to result in a smaller amount of influence in the system, which in turn decreases the likelihood of a common opinion; yet these effects may also depend on other dimensions of the system, notably tie formation criteria, and may vary with the flow of turnover.

Effects of Membership Duration

Turnover is likely to significantly affect organizations. People join and leave, and the time members spend within the organization will affect the socialization of others, as well as their influence on others. At micro-level, turnover changes the structural properties of an organizational advice network: as people enter and leave an organization, advice networks reconfigure themselves. Krackhardt and Porter (1985) investigated the effect of turnover on the attitudes of organizational members who remain in the organization. They found that the closer employees were to those who left, the more satisfied and committed they became. At macro-level, Harrison and Carroll (1991, 2006) simulated joiners and leavers who affect each other's enculturation through a social network, revealing that an emergent organizational property is the cultural heterogeneity of the organization.

We thus investigate the effects of duration of membership on opinion transmission. Notice that with a fixed-size population, duration of membership is perfectly equivalent to membership renewal rate: a low number of entries and exits implies that it takes relatively long before the initial population is entirely replaced, and members remain in the organization for a relatively long time; with the same organization size, higher flows of joiners and leavers imply a shorter duration of membership. Overall, we expect the process of social influence to be less effective in harmonizing members' views with higher flows of joiners and leavers (or shorter durations of membership), so that a shared opinion may not emerge, or not be stable.

MODEL SPECIFICATION

We develop an agent-based simulation model of social influence over an advice network with changing composition in the form of a flow of joiners and leavers. The model addresses the two interrelated issues of the process through which opinions may change in bilateral (dyadic) meetings, and the global structure of interactions that determine which agent meets which other agent (Friedkin & Johnsen, 1999). Our account of social influence at dyadic level remains very close to the "relative agreement" model of Deffuant et al. (2002), apart from a detail (see below); we also follow this literature in defining heterogeneities in the population of interest, and focusing on the influence of one part of the population on the others. We change the global structure of interactions, though, by removing the simplifying assumptions of fixed population and of random selection: these are our main innovations relative to the agent-based modeling tradition.

The dynamics of the model involves a population of fixed size, where each agent who leaves is replaced by a new agent, with an update at every time-step. Agents interact ten times at each step and each interaction potentially leads to individuals' evolution of opinions[1]. At the end of each step we observe agents' opinions; more precisely, we observe the average over the whole population as well as the evolution in each agent's own history. Let us now turn to the specification of our model. We describe how we model agents' attributes, the process of social influence, the process of advice tie formation, and the simulation structure and outcomes.

Agents' attributes

Each agent i is endowed with three attributes: age, opinion, and latitude of acceptance, which are used to formalize the social processes of advice tie formation and social influence. These three attributes are given at initialization, and may evolve over time.

Age (a_i^t) is the number of time-steps that agent i has already spent in the organization at time t. Age varies between 1 and total membership duration D, which is an attribute common to all and is a defining feature of a simulation. Based on age distribution and membership duration, we can define a "generation" as the number of time-steps that must elapse before a population is completely renewed.

1 The time-step is here a stylized representation of the "year" used in the model of the Commercial Court of Paris (Rouchier, & Tubaro, 2011), where agents work for ten months every year and are replaced at the end of the fourteenth year. We align on this model by assuming one advice-seeking interaction every month.

The values of age and membership duration also enable distinguishing two groups in the population: seniors, whose age is more than half the duration ($a_i^t > \frac{D}{2}$), and juniors whose age is lower ($a_i^t \leq \frac{D}{2}$). The qualification of senior or junior is not an intrinsic agent parameter and depends on age, though it is attributed randomly at initialization, as explained below.

Opinion is a scalar, continuous variable, defined for agent i at time t as a real number $o_i^t \in [0; 1]$. Continuity allows individual positions to vary smoothly between extremes, so that nuances can be accounted for. In other words, a notion of "distance" between two positions can be defined – measuring the extent to which they are close to each other but without requiring them to be identical. This formalism also enables identifying clusters of opinions at the system level (see below).

Latitude of acceptance – a term which we borrow from Jager & Amblard (2004) in place of the "uncertainty" of Deffuant et al. (2002) – is also a scalar, continuous variable, defined for agent i at time t as $l_i^t \in [0; 1]$. Latitude of acceptance is an indicator of members' willingness to absorb the opinions of others – the agent is indeed able to perceive, and be influenced by, any opinion in its "opinion segment" $[o_i^t - l_i^t ; o_i^t + l_i^t]$ (Deffuant et al., 2002). In the agent-based literature, this attribute expresses agents' bounded confidence, or the idea that an agent can be influenced by another only if their opinions are close enough (Deffuant et al., 2001; Deffuant et al., 2002; Deffuant, 2006; Fortunato, 2004; Hegselmann & Krause, 2002; Kułakowski, 2009; Malarz, Gronek & Kułakowski, 2011). Heterogeneous levels of latitude of acceptance are known to substantially affect results (Rouchier & Tanimura, 2012).

Social influence: a variant of the relative agreement model

Once advisor (i) and advisee (j) have been matched (see below), the advisee can be influenced. In line with the bounded-confidence approach, this occurs only if j's opinion is in the opinion segment of i, that is: $o_j^t \in [o_i^t - l_i^t ; o_i^t + l_i^t]$.

If this is true, influence occurs following relative agreement, a measure that is based on the overlap of both agents' opinion segments (h_{ij} , defined in Eq. 1) relative to the non-overlap (defined in Eq. 2), and calculated as overlap minus non-overlap, divided by the length of i's opinion segment (defined in Eq. 3).

Eq. 1

$$2l_i^t - h_{ij}^t$$

Eq. 2

$$\frac{2(h_{ij}^t - l_j^t)}{2l_i^t}$$

Eq. 3

Both j's opinion and j's latitude of acceptance are then transformed through relative agreement, weighted by the distance between opinion and parameter μ, which settles the speed of adjustment between time t and time t + 1.

Eq. 4

Eq. 5

The original mechanism of influence is non-symmetric, so that the agent with larger latitude of acceptance will be more influenced than the other. A central tenet of our model is that the asymmetry is enhanced: the advisee j is influenced by the advisor i, but not the reverse.

Advice tie formation: random choice, experience and homophily

A first mode of advisor selection is pure randomness – agent j probabilistically choosing an advisor i among all other agents. Though knowingly unrealistic, this criterion allows comparison with results of existing agent-based models, and constitutes a benchmark for other selection criteria.

We also model advisor selection based on experience, a tendency for agents to seek advice from others that joined at the same time as themselves or earlier; put differently, to choose advisors whose age is equal to, or higher than, their own. This is a variant of Harrison and Carroll's cohort effect

(2002), placing emphasis on time spent in the organization as an indicator of expected insight from advice. Choice is random from among the set of agents that meet the criterion.

The other alternative is value-related homophily, a tendency of individuals to seek advice from those with similar opinions. An agent j will select randomly from among the set of agents i such that $o_j^t \in [o_i^t - l_i^t ; o_i^t + l_i^t]$. Because in a dynamic model, opinions may be close at some moment in time but diverge afterwards, we also regard as homophilous the choice of agents that influenced the advice-seeker in the past, even when their current opinions are distant. To summarize, homophily restricts advisor choice to agents that can influence the advice seeker, or influenced it at some earlier time. With this restriction, influence will almost always take place, and one can expect to see an acceleration of the convergence process, compared to random choice.

Finally, we combine experience and homophily. In this case, the agent chooses randomly from among the agents in the intersection of the two sets.

Simulation structure

A simulation consists of a succession of generations, each consisting in D time-steps, where all agent interactions occur according to one advisor selection criterion only: random choice, experience, homophily, or experience –homophily.

At initialization, 200 agents are created – the same size of the population considered in Deffuant et al. (2002) and in other agent-based literature; comparable with the Commercial Court of Paris (about 150 judges); and rather realistic in conjunction with the assumption that all agents can potentially interact with all other agents. However, it is acknowledged that population size affects the results of the model dynamics, so that caution must be exerted before any generalization.

As explained above, an agent i is initialized with an age, an opinion and a latitude of acceptance. The number of agents for each age is the same, and equal to $\frac{200}{D}$, where D is duration of membership. We distinguish between senior and junior agents, to create a major element of heterogeneity in the population, and explore its effects. Indeed we assume that all senior agents have

the same opinion and latitude of acceptance, to observe if this initial opinion will durably affect the system: they have an opinion of 0.2 and a latitude of acceptance of 0.2, both close to one end of the admissible range. Instead, junior agents are initialized with an opinion that is randomly drawn from a uniform distribution over the [0; 1] real interval, and a latitude of acceptance higher than, or at least equal to, 0.2. Subsequently newcomers, who enter the system at each time-step, are defined like initial junior agents, with random opinion and larger latitude of acceptance. These parameter values represent the idea that senior agents share an orientation towards one extreme of the possible values of opinion and are rather self-confident, while juniors are more scattered due to their necessarily diverse backgrounds, and more likely to absorb other members' opinion as part of their socialization process. From this starting point, we can observe if opinions converge in the long run toward the value of 0.2 initially held by seniors – put differently, if the global structure of interactions, mediated by the advice network, sustains the initial bias towards a particular opinion. This would indicate that some agents (i.e., seniors) are more likely to spread their opinions to others, and that long-term persistence of an opinion is indeed possible even with membership turnover. Instead, agents would appear as more equal if opinions simply converged towards the midpoint of the acceptable range of opinions (here, 0.5): this would mean that the initial senior opinion has faded away after some time, and newcomers with their more varied views, have been able to exert a substantial influence on the system. In the latter case, there would be little need for a model of the structure of interactions that is significantly different from random choice and gives greater weight to some agents relative to others: the results already obtained in previous agent-based modeling literature would suffice.

A time-step is made of ten rounds of interactions. In a round, each agent chooses an advisor according to the stated criterion. We simulate a parallel choice for all agents at each round, where all calculate the influence they incur (if any) and update their opinions. After ten rounds, the new values of opinion for each agent are observed, ages are updated, and all agents of age D exit the system, to be replaced by newcomers of age 1. The time-step is then over.

After one generation (D time-steps), all agents that were present at initialization have left, and the population has been entirely replaced. We observe the properties of the system after a few generations,

when the population has been renewed several times; to do so, we use the distinction between seniors and juniors to take full account of the dynamics of the model. At this point, only seniors' opinions are of interest: they have stayed long enough to have their opinion evolve and reveal if there is still some influence of the opinion of those who were seniors at initialization. We observe seniors' opinions both in the medium run (5 generations), and in the long run (50 generations). These long run simulations are not meant to represent real-world situations, since it is unlikely that an organization could stay unchanged in structure for such a long time. However, they capture the asymptotic behavior of the model, and its eventual tendency to converge towards: (i) consensual opinion towards the mean of the accepted opinion range, with very quick disappearance of the influence of the initial opinion of seniors; (ii) consensual opinion with a value that is eventually near the mean, but after being long influenced by the initial setting; (iii) long-lasting influence of the initial setting with consensual opinion near 0.2, or polarization around two opposite opinions, one of which is 0.2. These results are essential for us to establish the extent to which the initial bias can be stable, as discussed above, and to better understand the dynamics of convergence. We thus aim to detect how variations of the different parameters induce one or the other of these scenarios.

To summarize, the values that define one simulation are: advisor selection criterion (random, experience, homophily, experience-homophily), latitude of acceptance of juniors and newcomers (from 0.2 to 1) and membership duration (from 2 to 50). Table 1 summarizes our model design.

[Insert Table 1 about here]

Indicators

The most relevant indicator is based on the final opinion of those agents who are senior at the time the simulation run is over, that is, those who entered the organization several years before and therefore, have been inside for enough time to be influenced by others. Specifically, we observe the average and the standard deviation of seniors' opinions. We also monitor the number of "groups of opinion", or clusters, in which seniors are situated at the end of a simulation run. The groups of opinion are defined in the same way as in Deffuant (2006). The method consists in defining a minimum distance between the opinions of two agents, below which they are said to belong to the

same cluster. The clusters are computed as sub-groups of agents such that (i) between any couple of agents in the sub-group either the distance of their opinions is below the threshold or (ii) there is another agent with intermediate opinion between them. Within this framework, emergence of one cluster corresponds to consensus of all agents around a common view, and two or more clusters will indicate fragmentation into sub-groups within which members tend to think alike, while divergences between sub-groups are insurmountable. We take slightly different values relative to Deffuant (2006), with a threshold of 0.05 so that, if one takes any two agents in the group, either the difference between their two opinions is lower than 0.05 or there exist agents in the group with intermediary opinion of distance less that 0.05 from one of the two. For example, 5 senior agents of opinion 0.24, 0.28, 0.29, 0.32 and 0.34 form one group; whereas if their opinions are 0.24, 0.28, 0.29, 0.35 and 0.38, then they form two groups. It is thus possible to establish if, for a given average opinion, there is consensus, polarization or fragmentation. This method has the advantage of relying solely on endogenous criteria for the definition of clusters, without requiring the modeler to arbitrarily specify reference values of opinion.

SIMULATION RESULTS

In all simulations, agents are influenced towards an opinion that they are not the only ones to hold, be it only one opinion or several. This is in itself a quite important result, in line with all existing agent-based literature on the topic, even though we are the first to introduce turnover.

Advisor selection criteria

We first run a set of simulations with different advisor selection criteria, but the same latitude of acceptance for newcomers (0.7) and membership duration (10). Figure 1 displays agents as points of coordinates equal to their age (horizontal axis) and opinion (vertical axis) after five generations of 10 time-steps. As usual opinion is allowed to vary between 0 and 1 and in this case, age ranges between 1 and 10, there are 20 agents for each age level, and senior agents are those with an age between 6 and 10. Junior agents have rather high latitude of acceptance at the time they join, 0.7, and we explore the simulation dynamics for each advisor selection criterion. These results are highly stable: with given initial conditions, the resulting dynamics and tendencies are the same in all simulations.

[Insert Figure 1 about here]

Random. The random choice of advisors yields convergence to a single value that tends to coincide with the midpoint of the allowed range of opinions, and does not depend on the initial opinion of seniors. This is in line with Deffuant's results (2002) when all agents start with the characteristics of our juniors, independently of turnover. The reason is that with random choice, junior and senior agents are equally subject to influence and even newcomers can exert an influence, so that the effect of the initial opinion of seniors fades away very quickly. The latitude of acceptance also converges to the value of the newcomers, 0.7, due to their possibility to influence seniors as well as to be influenced.

Homophily. Similarly, homophily yields consensus towards the midpoint of the distribution. This result is, in fact, predictable, since the possibility of juniors and newcomers to influence seniors is also present. The only difference relative to the random rule is that agents only interact with those who can influence them, or have influenced them before. Simulations show that this characteristic does not change the dynamics in this case.

Experience and Homophily-Experience. When advice is sought from agents of equal or higher age, whether or not in combination with homophily, there is alignment on a value of opinion that is close to that of initial senior agents. The experience and homophily-experience rules do not allow initial senior agents to be influenced by juniors, while due to their high latitude of acceptance, the latter are very influenceable, so that their opinions will gradually tend to get closer to those of seniors. The injection of newcomers at each time step does not counter this process as they will themselves seek advice from those who have been longer in the organization than themselves, and they will also be driven towards the same value of opinion. Their latitude of acceptance changes in this process as well and because of influence by senior agents, it tends towards 0.2. In the conditions we set (10 time-steps for a generation and a rather high latitude of acceptance initially) the initial senior agents have the opportunity to influence the organization in the long term when experience matters.

These tendencies are confirmed in the long run. Figure 2 shows the mean value of opinion and latitude of acceptance for senior agents over 50 generations (500 time-steps, with one mean opinion and one mean latitude of acceptance recorded at each step). Experience and experience-homophily are almost identical regarding these indicators; with these two criteria the initial setting has noticeable effects for a number of generations that is higher than what any organization could predictably last. Under these conditions, the effect of the initial opinion diminishes over time, almost linearly – there is influence, but not strongly enough to steer newcomers rapidly towards the opinion of the initial senior agents, so that social reproduction is imperfect.

[Insert Figure 2 about here]

The simulations with random choice and experience confirm existing knowledge of, respectively, the internal dynamics of the Deffuant et al. (2002) model, and the importance of seniority structures and hierarchy in organizations. Homophily produces more surprising outcomes, and appears as a less relevant social process than usually believed: whether or not agents interact more with those who hold a similar opinion, seems to matter little for the evolution of their opinions – although we will see later that its role is sometimes more complex.

These first results suggest that for the initial opinion of seniors to be transmitted to later generations despite turnover, experience is necessary. Varying the other two parameters will enable us to determine the conditions under which this result holds.

Effects of latitude of acceptance

We now run simulations with different levels of juniors' latitude of acceptance (seniors' latitude of acceptance remains equal to 0.2 in all simulations), for each advisor selection criterion and with constant membership duration of 10 time-steps. With higher latitude, the opinion diffusion process is facilitated and results remain about the same as shown above. With lower latitude of acceptance, the opinion diffusion process is made more difficult as junior agents (including newcomers) are less open to influence by others, in particular by seniors. Figure 3 shows that in this case, fragmentation and polarization of agents into two or more sub-groups of opinion may appear.

[Insert Figure 3 about here]

Random. With random choice, coexistence of two clusters of opinion is rare since they must be separated by at least the value of initial latitude of acceptance – otherwise one group is ultimately absorbed by the other, despite some initial noise. There is no convergence with a latitude of acceptance of 0.2, polarization around two different opinions with latitude of acceptance of 0.3, and convergence to one opinion, corresponding to the midpoint of the distribution, in all other cases. Convergence is slow, and accompanied by large deviations with a latitude of acceptance of 0.4 (as represented in Figure 3). Generally speaking, the higher the latitude of acceptance, the faster the convergence and the less dispersed the opinions, a result that is in line with all other research papers using the Deffuant et al. (2002) model.

Homophily. Homophily enables central convergence to appear sooner than in the case of randomness; no second cluster can be created with latitude of acceptance that is at least 0.4. From this value until 0.9, increases in initial junior latitude of acceptance do not change the behavior of the system, but can only slightly improve convergence and reduce the standard deviation. The effect of variations in the levels of juniors' latitude of acceptance is therefore less strong with this selection criterion.

Experience. When junior agents join with a latitude of acceptance that is as low as that of seniors, opinions remain very dispersed. Only when there is an initial difference between juniors and seniors does some convergence occur. Slightly increasing the latitude of acceptance of newcomers produces two groups, one being quite compact around the initial senior opinion of 0.2 and the other, more dispersed, around a value of opinion at a distance higher than the latitude of acceptance of newcomers. Eventually, the higher the latitude of acceptance of juniors, the less likely this second group is to appear and when junior latitude of acceptance exceeds 0.8, all senior agents end up with a final opinion very close to 0.2.

Homophily-Experience. When the latitude of acceptance of newcomers is similar to that of senior agents (0.2) there is convergence of opinions, not to a single value but to three different ones. It is the restriction of interactions only to agents that can exert an influence that leads to convergence to

multiple opinions. When latitude of acceptance increases to 0.3, only two groups of opinion form (with a distance of opinions that is higher than 0.3). As the latitude of acceptance of newcomers rises further, the homophily-experience criterion preserves two groups until the value of latitude of acceptance is very large; at and above 0.7, there is only one opinion for all agents, and group behavior is very close to experience situations.

Notice that results with juniors' latitude of acceptance of 0.2 are very similar to those that emerge with a fixed population (with no entry and exit of members) as in the original model of Deffuant et al. (2002). This value of latitude of acceptance, in fact, minimizes the impact of turnover as it makes junior and senior agents more similar. The reason why this effect appears only in homophily simulations is that agents in our model do not interact sufficiently often to achieve convergence, unless there is an accelerating factor – the homophilous choice which increases the number of influencing interactions.

The interesting result here is that with lower levels of latitude of acceptance, experience is no longer sufficient to preserve consensus around the initial opinion of seniors; it is only when homophily is added to it that consensus around the initial seniors' opinion can emerge, though it is accompanied by one or more alternatives. Put differently, under these more difficult conditions, homophily needs to be included in order for experience to ensure opinion transmission. This implies that contrary to what our very first results on advisor selection suggested (see above), homophily does matter —though in more complex ways that could be expected beforehand.

Effects of membership duration (or turnover rate)

We now consider different levels of membership duration, for each advisor selection criterion and with constant junior latitude of acceptance of 0.7. We take simulation runs of 50 time steps as before.

The idea is to see if, all other things being equal, the maximum time spent in the organization has an impact on the possibility to transmit an opinion to newcomers. As briefly mentioned above, a way of thinking about membership duration is the renewal rate of the population. To stay for 10 time-steps means that 10% of agents change at every step. To stay for 2 time-steps means that 50% of the

population is renewed at each time-step, for 4 time-steps - 25%, for 8 time-steps - 12,5%, for 20 time-steps - 5% and for 50 time-steps 2%. We test the effect of this parameter conditional on advisor selection criteria, always under the assumption that agents can interact with others ten times a year.

Three results hold for all selection criteria. First, renewal of 25 % or 50% of the population (2 or 4 time steps in the organization, respectively) does not allow the opinion of initial senior agents to be transmitted to newcomers; moreover, convergence cannot take place with duration of 2 (see Table 2). Second, increasing duration always implies more convergent opinions (with a smaller standard deviation, see Table 3). Third, when duration increases (above 20 steps) newcomers get influenced so quickly that after 4 time-steps they all are in a range of +/- 0.02 around the convergence value. The longer agents stay, the quicker newcomers get influenced. Apart from these three very general results, each advisor selection rule displays different characteristics.

[Insert Table 2 about here]

With experience and homophily-experience, higher membership duration leads the final opinion of senior agents towards 0.2 (i.e. the value of initial seniors) after 20 or more time-steps. Junior agents have an opinion that is very close to 0.2 after just three time-steps spent in the organization. Latitude of acceptance is also quite homogeneous and close to the initial latitude of acceptance of seniors, i.e. 0.2. Exceptions to this general result appear in some of the simulations with experience when duration is above 20, when a subgroup of agents is never influenced by the initial opinion of seniors.

Indeed with experience only, longer durations enable some senior agents to keep a discordant opinion (neatly different from 0.2, and typically situated above 0.5) and attract junior agents coming in with an opinion in that range, so that a subgroup of agents with opinion above 0.9 persist. Agents are divided into two clusters. The discordant-opinion group is small, including about or less than 10% of agents as shown in figure 4. Tables 3 and 4 provide details on homogeneity of opinion of the majority group and are evidence of the influence of the initial value of seniors' opinion.

[Insert Table 3 about here]

Inclusion of homophily with experience changes the global pattern. Without it, a newcomer with a very discordant opinion (notably higher than 0.9, which represents on average 10% of newcomers under a uniform distribution), is unlikely to be influenced by more experienced agents (i.e. those who joined 3 to 50 time-steps before), most of whom have an opinion of around 0.2. Only when such a junior meets agents with opinion higher than 0.9 will it be influenced, and will preserve its discordant value of opinion. Hence, these agents constitute a subgroup whose share is stable over time and represents about 10% of senior agents at the end. To support this argument, we have run simulations with a latitude of acceptance of juniors of 0.7, and a turnover of 2% and 5%, expecting the emergence of a subgroup of 19-20 senior agents sharing a discordant opinion. This is indeed the result we obtain on average, although the size of the subgroup can rise up until 29 in some simulation runs, in that agents with discordant opinion can also influence newcomers with intermediate values of opinion, thus increasing their share. Once the proportion is established, it reproduces itself over time since the probability to meet each type of more experienced agent generates a probability to be influenced, and hence attraction of a part of newcomers.

[Insert Table 4 about here]

This situation is unlikely to arise in simulations where agents interact only with agents that can influence them, since they necessarily do get influenced as soon as they join, and that can be either by very discordant (high) values or by intermediate values of opinions. As soon as a newcomer is influenced by an intermediate value of opinion, its opinion decreases and it becomes subject to influence by agents with opinion 0.2, i.e. the vast majority, so that its opinion goes quickly to 0.2. To force agents to interact with others only when they can get influenced tends to homogenize the group rather than segregate it, which is a pretty counterintuitive result[2].

[Insert Figure 4 about here]

In sum, longer duration of membership (or equivalently, lower turnover rate) is favorable for social influence to occur, and improves the transmission of an initially shared opinion. However, our result is asymmetric: shorter durations, corresponding to more difficult conditions for influence to

2 This result also holds when comparing homophily and random simulations, though to a much lesser extent.

occur, do hinder convergence to seniors' opinion, as expected; instead with longer durations, corresponding to ex ante more favorable conditions, outcomes are conditional on the advisor choice criterion (Figure 4). Specifically, experience alone yields polarization around two distinct and separate values, one of which is the initial opinion of seniors; experience in conjunction with homophily, instead, creates consensus around the initial opinion of seniors. Although there is opinion transmission in both cases, it is only when homophily is added to experience that alternatives disappear: again, it can be inferred that homophily matters, though its effects are displayed in a somewhat unexpected way. It is a sign of the complexity of the system, where the final results depend on combinations of initial conditions and modes of interaction, and cannot be predicted based on individual behaviors alone.

These results provide insight into the implications of homophilous selection of advisors on macro-level opinion transmission. In a system with turnover and asymmetric dyadic influence, homophily does not produce polarization as a regular outcome, in contrast to the findings of Kozma and Barrat (2008). Rather, our results point to the role of homophily as an accelerating factor, which facilitates convergence towards a consensus, whether it is towards the midpoint of the distribution (homophily alone) or to the initial opinion of seniors (homophily in conjunction with experience). In particular, it is only by adding homophily to experience that opinion transmission is possible when the circumstances under which influence occurs become more difficult (lower latitude of acceptance of newcomers) or more convoluted (longer durations). Somewhat counter-intuitively, homophily acts as a homogenizing factor in these cases, contributing to driving a majority of opinions toward the value initially held by seniors, thereby decisively contributing to consensus formation.

DISCUSSION

The most interesting, and least predictable of our results are those on homophily, which challenge received wisdom under many respects. Previous studies often portrayed homophily as a factor of differentiation, inducing formation of clusters with strong internal homogeneity of opinion and sharp dissimilarity between them. Yet homophily (interpreted here as value homophily, or similarity of opinions) emerges from our work as a facilitating factor for global consensus. Taken in isolation, it

acts as an accelerated version of randomness, smoothing the progress of convergence towards the mean of the distribution of opinions. In conjunction with experience, it dramatically changes results in favor of consensus around the view of the most experienced agents. Especially when conditions of interaction become more complex or difficult, experience alone is insufficient to foster homogenization of opinions: it is only by adding homophily that this can happen. In some cases, the force of homophily combined with experience is enough to bring about a consensus; in other cases, it can at least reduce the degree of fragmentation of the system, inducing the formation of fewer separate clusters (two in the extreme case of polarization). The explanation of these apparently counter-intuitive results depends on the whole set of inter-related circumstances at play, and interestingly for our purposes, changes what was known about the sheer effects of randomness and experience.

Our other results are largely in line with both the agent-based and organizational literatures. More precisely, our outcomes under the random choice assumption mirror those that Deffuant et al. (2002) obtained under similar conditions (except turnover); and our experience-driven simulations in essence confirm the findings of a long and well-established tradition that has highlighted the role of seniority and tenure in organizations. Notice, however, that our results on experience depend on relatively loose conditions that do not require strict hierarchical rules: it suffices that members seek advice from those who are no less senior than themselves, a category that also includes same-seniority peers. What is more, a hierarchical structure valuing seniority does not per se produce transmission of shared understandings, since this result hinges upon a combination of interrelated factors. We also stress the importance of the latitude of acceptance of newcomers – in the context of an organization, one can interpret a setting with high latitude of acceptance as one where newcomers know little about what is the central topic of the organization and hence have no strong view on it; on the opposite a low latitude of acceptance, where newcomers are not easily influenced, may concern settings where the organization involves less specific knowledge that the newcomers already have, and in that context the point of view that was initially prevalent in the system is quickly erased.

The simulations provide evidence that the tendency of opinions, represented as positions in the real interval [0; 1], to converge can be affected by networked interactions, agent attributes, and

externally imposed constraints (particularly time factors). In particular, network formation rules may constrain influence so that it moves only from more to less senior agents. In such cases, a bias in opinion may persist for long after the initial advocates of that opinion have left the scene, a result that cannot be obtained under the simplifying assumption that network ties are formed randomly. More complex conditions may also sustain a biased opinion, though in conjunction with a (usually very different) alternative: again, this result does not emerge under sheer randomness. To further substantiate this point, notice that another way in which simulations may benefit the study of organizations relates to the Deffuant (2002) model itself: its representation of opinion as a continuous variable and the inclusion of the latitude of acceptance, functioning as a threshold below which influence cannot occur, support a refined view of opinion transmission that suits well the subtlety and sophistication of organizational contexts, and may open the way to further theoretical developments. On the other hand, ours is the first attempt to extend Deffuant's approach to situations in which agents enter and exit the network. This property creates a form of implicit hierarchy based on time spent in the institution that may affect advisor selection, and we have shown that under given conditions, it yields different systemic outcomes, compared to the original model.

Our study reveals that all three factors under study, namely advisor selection rule, initial latitude of acceptance of newcomers, and duration of membership (or turnover rate), affect the system. Only for certain values of parameters can an opinion be transmitted to newer generations of members; and some of the advisor selection criteria are inconsistent with any form of opinion transmission. Under realistic values of junior latitude and turnover rate, three different scenarios arise from our simulations: a first scenario is one in which all agents constitute one group with opinion around 0.5 – which means that there is convergence to a unique value without any historical impact of the initial value of the opinion of seniors; in a second scenario, all agents constitute one group with opinion significantly lower than 0.5 – which means that the initial value of the opinion of seniors has an effect over several generations (although such an effect fades away progressively in the very long run); and a third scenario is one in which two groups co-exist and newcomers are driven towards the one or the other depending on their initial opinion.

It is important to notice that there is no unique way to attain any one of these three states in this system, which responds differently to different combinations of parameters. While random choice and homophily almost always drive the system towards the first scenario (consensus around the midpoint of the distribution), they may degenerate into a case of non-convergence for very low values of latitude of acceptance. Experience drives the system towards the second scenario (consensus around the initial opinion of seniors), but fails to achieve convergence for low values of latitude of acceptance, and yields polarization (third scenario) with longer durations. Combined with homophily, experience does better in that it achieves at least polarization with low latitude of acceptance, and consensus to the initial opinion of seniors, with long durations. Interestingly, these outcomes necessitate compound analyses – as is the case with any "complex system".

These results illuminate the social processes going on at the Commercial Court of Paris, the empirical case that inspired our work. Previous empirical research (Lazega et al. 2012) indicates that the dynamics of the advice network is driven by status, a notion that includes seniority as one of its key components and loosely corresponds to our experience, rather than by opinion homophily, and that the judges are often divided into opposing camps on essential judicial questions (Lazega et al. 2012; Lazega et al. 2011). Our study reveals possible mechanisms through which, over the centuries-long duration of activity of the Court, transmission of opinions driven by seniors' primacy eventually gives rise to polarization. This result can account for the existing evidence, and could not have been obtained with any other methods, as available data are insufficient to allow detailed longitudinal statistical analyses of opinion change. Insight into the transmission of opinions at the Court is important to better understand how judges form their views on matters that will affect their judicial decision-making, with potential repercussions on the regulation of the economy.

Admittedly, we have used stylized versions of the empirically thicker, and conceptually richer, research on the Commercial Court that initially inspired our thoughts. These simplifications have left aside numerous details – such as frequency of advice, noise in the communication process, other heterogeneities among judges. By stripping away these details, some readers may fear that – as any other simulation model – ours is too abstract to yield valid insights (Fine & Elsbach, 2000). Yet, such

simplifications are helpful to bring to light the different patterns that emerge at the level of the system as a whole, from just a few basic assumptions at the individual and dyadic levels. The properties of the model reveal which combinations of conditions bring about the possible scenarios of consensus, polarization and fragmentation. In this sense, our work not only makes the case that insight from organization studies improves the reliability of computer simulations, but also the reverse –that agent-based methods can widen the range and general applicability of organizational research findings.

CONCLUSION

Our model provides computational evidence that in an organization with a flow of entries and exits, social influence can explain convergence of opinions of members, even when those originally holding the opinion leave the organization at an early stage. The model brings to light the conditions under which convergence of opinions occurs as well as the factors underlying the emergence of different scenarios. Our results are not only consistent with existing knowledge, they also provide innovative insight into how different criteria of selection of network ties affect transmission of opinions throughout the system over time, even when assuming the same micro-level mechanism of dyadic influence in all cases.

Our model was originally derived from the case study of a real-world organization, the Commercial Court of Paris; we have abstracted from its idiosyncrasies to highlight only its most generalizable features, those that are confirmed and documented in the wider organizational literature. Our findings shed new light on how organizations can smooth or expedite their internal processes of assimilation, transmission, and sharing of ideas or opinions. For example, they may find ways to facilitate exchanges and contact between like-minded members in order to reinforce some process of transmission of ideas that is already occurring due to experience-related factors, as often happens in organizational settings in which length of service matters.

Possible extensions of our study can be theoretical and empirical. One could test the sensitivity of our results to changes in the size of the organization, which has been shown to be a key parameter in many influence models (Jager & Amblard, 2004). One could also consider a slightly different model of influence in which interactions not only draw agents' opinions closer to each other, but may also

drive them further apart if a negative influence takes place (as in Jager & Amblard, 2004). Another interesting extension could be to test a further selection criterion, such as centrality of agents – the idea that more sought-out agents are more likely to attract formation of new ties over time.

We find that homophily has a very strong impact on the agents' opinions. One could thus enrich this construct through a more detailed representation of how homophily is experienced by individuals. Use of real-world organizational data may in particular relate homophily not only to (endogenous) opinion, but also to (exogenous) demographic factors such as gender, age, or nationality. Because diversity along demographic dimensions cannot be eliminated or reduced, we expect it to make overall convergence more difficult, further stressing the crucial role of value homophily alone in achieving consensus.

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FIGURES

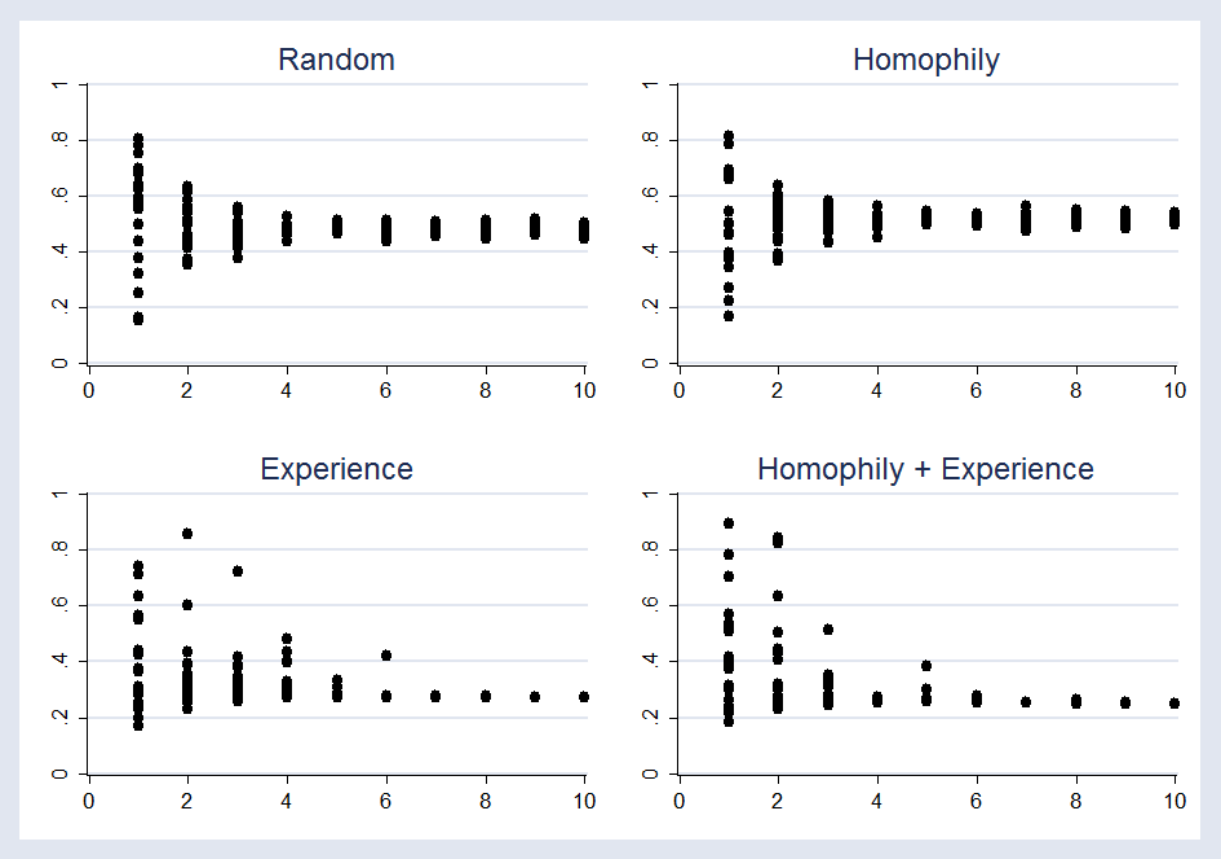

Figure 1: Final opinion of each agent (vertical axis) as a function of age (horizontal axis). Simulations with 200 agents, duration of 10 time-steps, initial opinion of senior agents of 0.2, initial latitude of acceptance of senior agents of 0.2, and initial latitude of juniors of 0.7. Results are taken after 50 time-steps, or 5 generations of agents. There are 20 agents for each level of age, which by definition varies between 1 and 10 (duration); at any one time, agents whose age is between 6 and 10 are seniors. The levels and dispersion of the opinions of those who are senior at the end of the simulation are the most meaningful indicators of whether there has been convergence, and if yes, to what values of opinion.

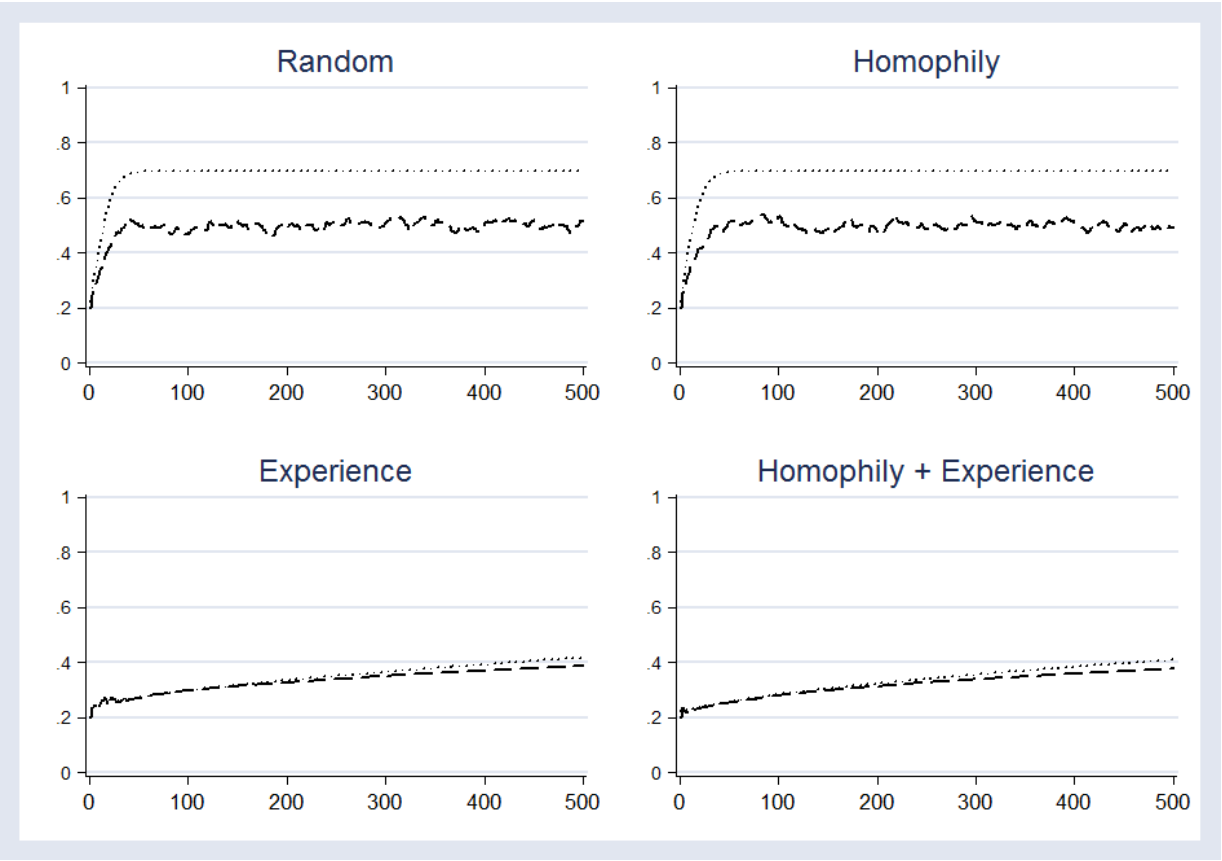

Figure 2: Evolution of mean opinion (dashes) and mean uncertainty (dots) of senior agents (vertical axis) over time (horizontal axis). Long-run simulations of 500 time-steps with 200 agents, membership duration of 10 time-steps, initial opinion of seniors of 0.2, initial latitude of acceptance of seniors of 0.2, latitude of acceptance of initial juniors and newcomers of 0.7. Agents whose age is between 6 and 10 are seniors.

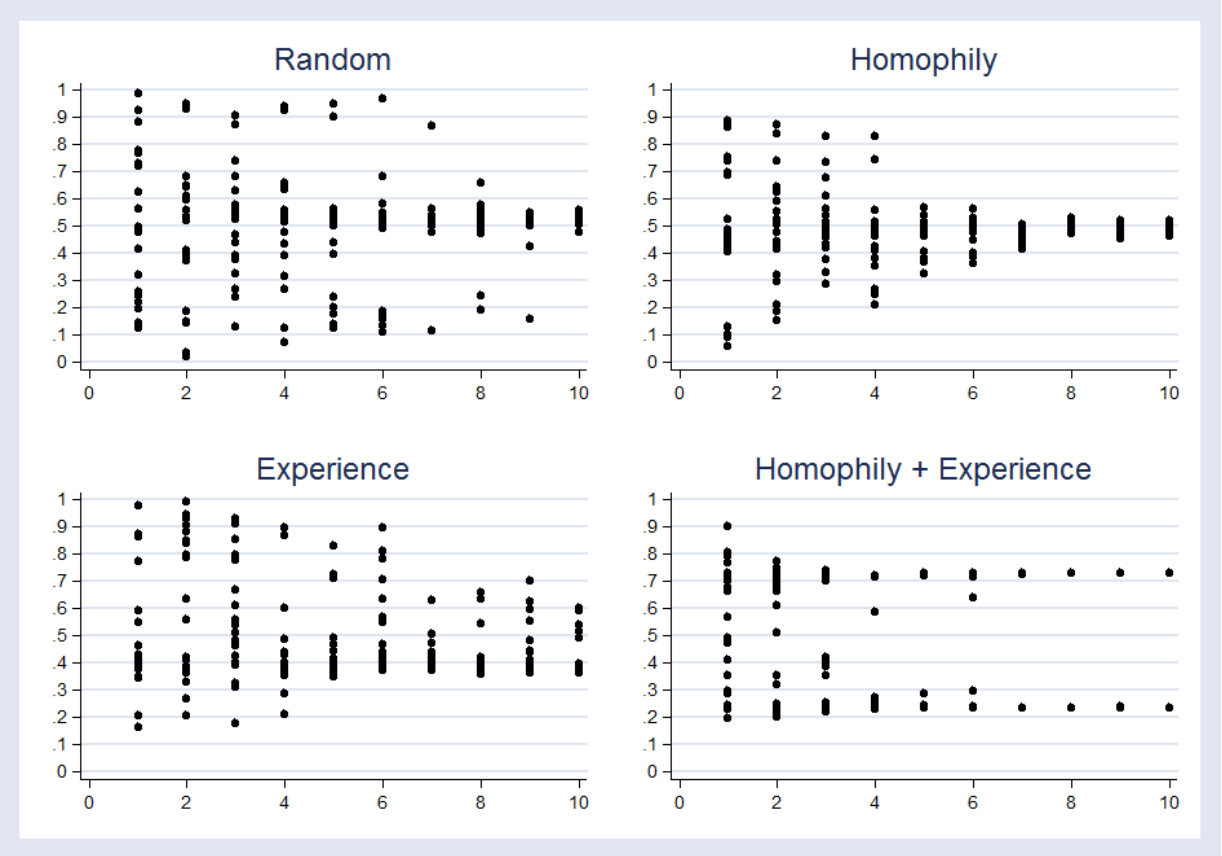

Figure 3: Final opinion of each agent (vertical axis) as a function of age (horizontal axis). Simulations with 200 agents, duration of 10 time-steps, initial opinion of senior agents of 0.2, initial latitude of acceptance of senior agents of 0.2, and initial latitude of juniors of 0.4. Results are taken after 50 time-steps, or 5 generations. There are 20 agents for each level of age, and at any one time, agents whose age is between 6 and 10 are seniors. The levels and dispersion of the opinions of those who are senior at the end of the simulation are the most meaningful indicators of whether there has been convergence, and if yes, to what values of opinion.

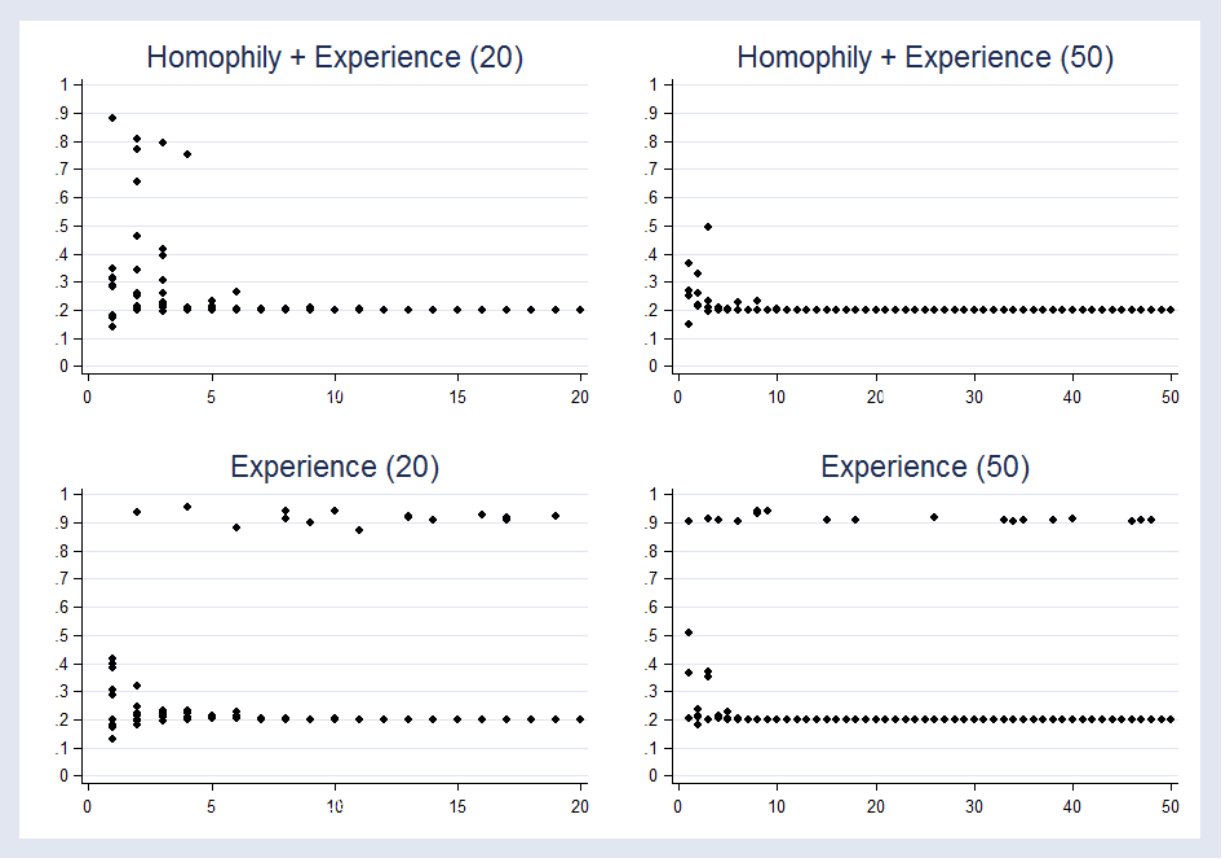

Figure 4: Final opinion of each agent (vertical axis) as a function of age (horizontal axis), Simulations with 200 agents, duration of 20 and 50 time-steps respectively, initial opinion of senior agents of 0.2, initial latitude of acceptance of senior agents of 0.2, and initial latitude of juniors of 0.7. Results are taken after 50 time-steps in all cases. When duration is 20, age varies between 1 and 20, there are 10 agents for each level of age, and seniors are agents whose age is over 10. When duration is 50, age varies between 1 and 50, there are 4 agents for each level of age, and agents whose age is over 25 are seniors. The levels and dispersion of the opinions of those who are senior at the end of the simulation are the most meaningful indicators of whether there has been convergence, and if yes, to what values of opinion.

TABLES

Parameters	**Range of values**
Initial opinion of Junior agents	U [0;1]
Initial opinion of Senior agents	0.2
Initial latitude of acceptance Junior agents	0.2 ; 0.3 ; 0.4 ; 0.5 ; 0.6; 0.7; 0.8 ; 0.9
Initial latitude of acceptance Senior agents	0.2
Number of agents	200
Duration of membership (D)	2; 4 ; 8; 10 ; 20 ; 50
μ	0.2
Selection criteria	Random, Homophily, Experience, Experience-Homophily
Number of generations	5 ; 50
Observed data	
Definition of Junior vs Senior agents	Length of stay < D / 2 vs > D/2
Average opinion of Senior agents	
Opinion as a function of length of stay in the Court	
Sub-group differentiation	0.05

Table 1: Parameters and indicators of the model.

Membership duration	**Random**	**Homophily**	**Experience**	**Homophily + Experience**
2	0.23	0.2	0.14	0.16
4	0.03	0.01	0.03	0

Table 2: standard deviation of final senior opinions from the mean, for each selection criterion. Averages taken over 100 simulations for each combination of parameters. Durations of 2 and 4 (turnover rate of 50 and 25 % respectively). The average opinion is always close to 0.5, in all these cases.

Membership duration	**2**	**4**	**8**	**10**	**15**	**20**	**25**	**50**
Average Opinion	0.51	0.48	0.34	0.26	0.25	0.2	0.2	0.2
Opinion st. dev.	0.14	0.03	0.002	0.01	0	0	0	0
Latitude of acceptance	0.7	0.7	0.37	0.27	0.24	0.2	0.2	0.2
Number of agents in discordant-opinion group	0	0	0	0	7 (6.6%)	9 (9%)	6 (6%)	10 (10%)

Table 3: Effects of membership duration in experience simulations. Averages taken over 100 simulations for each combination of parameters. For increasing maximum membership duration (lower turnover), the average values of opinion and latitude of acceptance tend to 0.2, and a group of agents with discordant opinion tend to appear. Recall that opinion and latitude of acceptance vary between 0 and 1 (0.2 being the value of both parameters for seniors at initialization), and the total number of agents is 200.

Membership duration	**2**	**4**	**8**	**10**	**15**	**20**	**25**	**50**
Average Opinion	0.49	0.49	0.31	0.25	0.2	0.2	0.2	0.2
Opinion st. dev.	0.16	0	0	0	0	0	0	0
Latitude of acceptance	0.7	0.67	0.34	0.25	0.2	0.2	0.2	0.2

Table 4: Effects of membership duration in homophily-experience simulations. Averages taken over 100 simulations for each combination of parameters. With higher maximum membership duration (lower turnover), the average values of opinion and latitude of acceptance tend to 0.2. Recall that opinion and latitude of acceptance vary between 0 and 1 (0.2 being the value of both parameters for seniors at initialization).