How Schwartz values influence social networks in the workplace

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Abstract. In the literature, human values are defined as "desirable, broad trans-situational goals that serve as guiding principles in human life". Shalom H. Schwartz introduced the concept of ten different human values and proposed their structure in the form of a circle. These individual values can influence the relationships between agents and, consequently, the structure of the entire social network. In this paper, we exploit data from the European Social Survey as well as our own unique experimental data to explore the mechanisms of this influence and analyse its consequences by the means of agent-based modelling. We present preliminary results that provide weak support for both proposed hypotheses: Schwartz values (i) lead to greater stability of social networks in the workplace and (ii) can differentiate agents' behaviours and the resulting positions in their workgroups.

Keywords: Agent-based modeling · Social networks · Schwartz values.

1 Introduction

The goal of this paper is to provide an explanation [3] by presenting potential mechanisms that may explain how individuals' Schwartz values influence the formation and evolution of social networks in the workplace.

The agent-based approach enables us not only to consider the heterogeneity but the local character of the agents' interactions as well. In the following paragraphs, we first introduce the concept of Schwartz values, then discuss the role of social networks in the workplace and finally we refer to the existing literature on how Schwartz values influence social networks.

Personal values guide and motivate people's perceptions, judgments, attitudes and actions [14,17]. They define what is important in life and provide a person-specific normative framework that stimulates value-consistent behaviour in different situations. Each person's value system is unique and hierarchical, meaning that some values are prioritised over others.

The Schwartz theory of human values [14,16] provides a widely recognised proposition of a circular structure of value domains consisting of ten basic values (19 in a later extended version), both compatible or competing ones. In its original formulation, the values Benevolence (BE), Universalism (UN), Tradition (TR), Conformity (CO), Security (SE), Power (PO), Achievement (AC), Hedonism (HE), Stimulation (ST), and Self-Direction (SD) form a motivational continuum that reflects the dynamic relationships among them [14,13,1].

The more any two values are adjacent to each other on the circle (e.g. BE and UN), the more congruent and positively related goals they represent. In this case, the underlying motives of each value can be realised in a single action. In contrast, opposing values (e.g. BE and AC) lead to conflicting actions and cannot be activated at the same time. Schwartz's values can be further aggregated into four higher-order value categories creating two bipolar dimensions [16]: Conservation vs. Openness to Change and Self-Transcendence vs. Self-Enhancement. Conservation and Self-Transcendence are associated with greater social focus and promote maintaining stability in relationships or pursuing the well-being of others (referred to as *group-centred* values from now on). Respectively, Openness to Change and Self-Enhancement place greater emphasis on person-centredness and direct individuals towards their own interests (referred to as *person-centred* values from now on).

Social networks in the workplace, be they of formal or informal origin, can manifest their influence in multiple aspects of organisational life: intra-organizational mobility (enhanced by having a large, sparse network of informal links to obtain information and resources) [12], individuals' Person-Organisation fit [19] and workplace performance (more central position in social networks in the workplace positively correlates with performance) [5], and organisations' learning ability and innovation [4].

[21] found that individual levels of conformity are linked to the social side of creativity in the workplace, showing that weak ties in social networks provide opportunity for creativity under the condition of low conformity values. The impact of Schwartz's model on the behaviour of people in a social network consisting of friends, relatives or colleagues was analysed in [18]. The authors analysed Twitter users' messages and were able to identify the Schwartz values important for the users. Schwartz values were shown to influence connections in each of the three social networks considered in the article. Further relations between Schwartz values and the role and connections in the friendship networks have been analysed in [9,7].

However, our work approaches social networks in the workplace from a different and more foundational angle, omitting typical discussions of implications for job performance, satisfaction, task fulfillment or other managerial topics. Instead we focus on the formation of intra-organisational social network clusters and how they might continuously change over time based on individual Schwartz values. For the purpose of this model, we explicitly exclude endogenisation of more formal networks (e.g. from organisational hierarchies or internal dependencies) and direct our attention towards informal social networks that form and evolve freely based on individual and group behaviour. We construct an agent-based model to investigate two research hypotheses:

H.1 Agent decision rules based on individual Schwartz values lead to greater stability of social networks at the workplace when compared to benchmark networks with decision rules not based on individual Schwartz values.
H.2 Agents driven by person-centred values change their social networks at the workplace more often than agents driven by group-centred values.

The remainder of this paper is structured as follows: Section 2 decribes the two data sets used throughout the model and Section 3 explains the empirical analysis of the experimental data. Section 4 covers the model creation with a synthetic population and its initial network structure as well as the details of the theoretical model and behavioural rules. The preliminary results of our computational simulations are presented and discussed in Section 5. Lastly, Section 6 concludes.

2 Data

We used two data sources:

1. the data from the ninth round of the European Social Survey (ESS9) to generate the agent population used in the model, and
2. the dataset with the results of the experiment carried out with the participation of students, used mainly to derive the behavioural rules of agents by means of econometric analysis.

The preparation of data from ESS9 was a two-step process. In the first step, all survey participants from Poland (1500), who were identified by the country code "PL", were selected.[4] In the second step, only 1165 participants with a positive number of total hours normally worked per week (including overtime) in their main job (designated by the field "wkhtot" in the survey), having pay as main source of income (the value of the field 'fvgabc" equal to one), and those for whom information about their Schwartz values was available were considered. Schwartz values are measured using the 21-item Portrait Values Questionnaire (PVQ) [2].

The experimental data comes from a series of behavioural experiments which was conducted over the time period from October 2020 until June 2021. A total of 258 Students of economics, economic psychology, and psychology from three Polish universities participated in at least one of the experiments. The students were randomly assigned into 35 groups having up to 10 members. The number of members in such a group resulted from the total size of the formal student

[4] Poland was selected to be in line with the participiants from our experimental data source but analysis and comparison of datasets with populations from other countries provide ample opportunity for further research.

group at the university. Finally, the students were awarded with additional credit points in their courses depending on their performance during the game.

At various times (beginning and end) of the semester the students were asked to complete a questionnaire in which they declared their willingness to cooperate with other students from the same group.[5] A total of 39 students groups were considered, out of which 8 participated in the questionnaire survey at the end of the semester. The average number of students in the group was 7.02 with minimum value 5 and maximum 10. Schwartz values for the students have also been measured using the 21-item Portrait Values Questionnaire.

3 Experimental data and econometric analyis

The purpose of the empirical analysis is twofold. Firstly, we identify correlations between an agent's individual Schwartz values and network measures. As the participants in the experiment created links in their social networrks voluntarily, such analysis may reveal their Schwartz values dependant preferences for network properties as a whole or their individual role (position) in these networks. Secondly, we estimate the parameters of the exponential random graph models (ERGM).[6] The results of the former analysis are used to derive the satisfaction rules for the agents, while the latter analysis makes it possible to create the whole network structure based on the Schwratz values of all the agents in the network.

First the correlations between the agents' Schwartz values and selected network measures were analysed. For the following self-oriented Schwartz values: Self-Direction, Stimulation, Hedonism, Achievement, and Power, we analysed the correlation of the Schwartz values with individual hub and authority scores.

The hub score [10] is defined as a principal eigenvector of the matrix AA^T, where A is the adjacency matrix of the graph. Similarly the authority score is a principal vector of the matrix $A^T A$. In both cases the vectors are scaled to have a maximum score of one and our implementation follows the iterative algorithm laid out in [8]. A simple interpretation in the context of workgroup networks might look like this: An agent is a good hub when they want to work with a lot of other agents with high authority scores. Conversely, an agent is a good authority when a lot of other agents with high hub scores want to work with them.

The eigenvector in-degree for the networks is calculated based on the centrality measures for all nodes as $s_c = \sum_{i \in I}(\bar{s}_c - s_{c,i})$, where $\bar{s}_c = \max(s_{c,i})$ and normalised by dividing by the potential maximum value for the in-star. The

[5] Possible answers were as follows: [5] "I am very willing to work with this person", [4] "I am eager to cooperate with this person", [3] "I somewhat want to cooperate with this person",[2] "I can cooperate with this person on a trial basis, but I have a lot of concerns", [1] "I do not want to cooperate with this person at all", [0] "I do not know this person".

[6] ERGM is a family of statistical models commonly used in the analysis of social networks, see [11,20] for the details.

Table 1: Estimated parameter values for the exponential random graph model with Schwartz values and for the randomised benchmark model.

	Value-based	Benchmark
N(1) edges	-0.62 (0.05)***	-0.57 (0.05)***
N(1) mutual	1.06 (0.08)***	0.95 (0.08)***
N(1) diff.h-t.PO	0.05 (0.05)	–
N(1) diff.h-t.AC	0.31 (0.05)***	–
N(1) diff.h-t.ST	-0.08 (0.05)	–
N(1) diff.h-t.SD	0.18 (0.05)***	–
N(1) diff.h-t.UN	0.18 (0.06)**	–
N(1) diff.h-t.CO	0.06 (0.04)	–
N(1) diff.h-t.TR	0.13 (0.04)**	–
AIC	3822.92	3884.38
BIC	3876.73	3896.34
Log Likelihood	-1902.46	-1940.19

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

in-degree centrality is the number of edges that point inward at a node. On an agent-level ($s_{c,i}$) this can simply be interpreted as the amount of people who want to work with them. In our case of workgroups, the centrality for a cluster (s_c) describes how widespread willingness to cooperate and work jointly are between its agents.

The resulting correlation coefficients are shown in Table 2 with significance levels given in parentheses. Two groups of Schwartz values can be distinguished: The first group consisting of SD, AC, and PO values correlates positively with authority score and negatively with hub score. The second group consisting of ST and HE values shows opposite signs of correlation, i.e. negative with authority score and positive with hub score.

Table 3 shows the correlation of group-oriented Schwartz values SE, CO, TR, BE, and UN with group in-degree centrality. TR is rather positively correlated with group in-degree centrality, whereas SE, CO, and UN exhibit negative correlation.

Schwartz values adjacent on the circular structure are normally highly positively correlated, while values on the opposite sides of the circular structure are negatively correlated [15]. This feature leads to methodological concerns related to multicollinearity. Following the advise by Schwartz to take up to eight Schwartz values as predictors, we have not taken HE, BE and SE into account in regression and further in the constructed agent-based model. The first two Schwartz values are relevant in other contexts than work, the latter was the

Table 2: Correlation between Schwartz values and hub score (s_h) and authority score (s_a). The superscripts mark if the questionnaire was carried out at the beginning of semester (1), end of semester (2), or at both times (1,2).

Value	s_h^1	s_a^1	s_h^2	s_a^2	$s_h^{1,2}$	$s_a^{1,2}$
SD	-0.14 (0.08)	0.04 (0.59)	-0.02 (0.90)	0.15 (0.26)	-0.11 (0.09)	0.06 (0.38)
ST	0.00 (0.97)	-0.08 (0.29)	0.21 (0.11)	-0.10 (0.45)	0.05 (0.48)	-0.08 (0.20)
HE	0.14 (0.06)	-0.16 (0.03)	0.13 (0.35)	-0.12 (0.39)	0.14 (0.03)	-0.15 (0.02)
AC	-0.15 (0.05)	0.17 (0.02)	-0.22 (0.11)	0.12 (0.38)	-0.17 (0.01)	0.16 (0.01)
PO	0.00 (0.98)	0.04 (0.57)	-0.20 (0.15)	0.21 (0.11)	-0.04 (0.54)	0.07 (0.26)

Table 3: Correlation between Schwartz values and group in-degree centrality (s_c).

Value	$s_c^{1,2}$
SE	-0.11 (0.51)
CO	-0.15 (0.37)
TR	0.14 (0.41)
BE	0.02 (0.92)
UN	-0.15 (0.36)

least correlated (without taking BE into account) with in-degree centrality, see Table 3.

4 Model

Our agent-based model consists of a stable set of agents conceptualised as nodes of a network in which a directed edge from agent i to agent j captures the willingness to work with said agent.

The general flow of one simulation step is as follows:

1. Agents each update their level of satisfaction with their current social network, taking into account individual Schwartz values and network measures.
2. Agent satisfaction influences their decision to change network, i.e. whether to remain in the current network or switch to a randomly chosen other one.
3. Lastly, connections with members of the new workgroup are made where the parameterisation of the coefficients for edge formation is based on the econometric analysis of our experimental data (see Table 1).

Generation of the synthetic population, estimation of the ERGM, and econometric analyses of the experimental data have been accomplished in the R programming language. The agent-based model has been fully implemented in the Julia programming language and the code is available online.

For the creation of $n = 2999$ model agents, we use a synthetic population generated from the data of the European Social Survey (ESS) round 9 for the selected country Poland, specifically also including the information on Schwartz values (see 2). To ensure that the constructed synthetic population is representative, we use the post-stratification weights to vary the multiplicity in which a given participant is taken into account.

Further, the agents are randomly assigned into smaller groups of up to ten agents depending on simulated initial network structures based on an estimated ERGM model. The nodes of the network represent the agents of the model and any edge from one agent i to another agent j within their shared network exists, when i wants to work with j.[7] This builds on the assumption that the willingness to work together is not always mutual, hence we use a directed graph for the network.

S_i is the satisfaction variable of agent i which is determined by their dominant (i.e. most important) Schwartz value.[8] It can take one of three potential values: 1 when agents are dissatisfied with their network structure, -1 when agents are satisfied, and 0 otherwise. We first calculate hub score s_h and authority score s_a on the node level (i.e. for each agent) and in-degree centrality s_c on the local graph level (i.e. for each cluster/workgroup). The rules proposed in Table 4 are based on the Schwartz values associated with person- vs. group-centredness and the results of the empirical analysis.

Table 4: Decision rules based on the Schwartz values.

Value	Satisfied, when:	Dissatisfied, when:
PO	$s_a > \delta_a^u(1)$	$s_a < \delta_a^d(1)$
AC, SD	$s_a > \delta_a^u(2)$ and $s_h < \delta_h^d(2)$	$s_a < \delta_a^d(3)$ or $s_h > \delta_h^u(3)$
ST	$s_a < \delta_a^d(2)$ and $s_h > \delta_h^u(2)$	$s_a > \delta_a^u(3)$ or $s_h < \delta_h^d(3)$
UN	$s_c < \delta_c^d(4)$	$s_c > \delta_c^u(4)$
TR, CO	$s_c > \delta_c^a(5)$	$s_c < \delta_c^d(5)$

The values of the various δ parameters were determined from the deciles of the distribution of measures for the entire population of agents and the initial social network structure, see Table 5. Specifically, for self-oriented Schwartz values (PO, AC, SD, ST), δs were chosen so that 30% of the population meets the

[7] If a participant selected the answers [5] or [4] in the questionnaire, we assumed that a directed edge from one node to another existed.

[8] In cases, where several Schwartz values are equally important, we randomly selected one of them. We will consider more sophisticated weighting mechanisms in the further research.

satisfaction condition and 30% meet the dissatisfaction condition.[9] For group-oriented Schwartz values (CO, TR, UN) the respective values were 45% and 15%. The asymmetry takes into consideration the following goals: devotion to the group, and preserving the existing social structure that underlay the group-oriented Schwartz values.

Table 5: Deciles for hub, authority, and in-degree centrality scores.

	10%	20%	30%	40%	50%	60%	70%	80%	90%
s_h	0.31	0.41	0.50	0.57	0.65	0.71	0.79	0.88	1.00
s_a	0.30	0.41	0.51	0.58	0.66	0.73	0.80	0.89	1.00
s_c	0.14	0.18	0.21	0.23	0.26	0.28	0.30	0.33	0.38

Agents change their networks with probability p_i and in that case randomly select a new potential network (unequal to the current one).

$$p_i = p_b + \Delta_p S_i \tag{1}$$

There are two simulation parameters: $p_b = 0.05$ is a base probability and $\Delta_p = 0.025$ is a multiplier that captures how the probability for network change varies due to agent i's satisfaction level S_i.

After a move between networks, the moving agent does not have any connections (edges) to other agents anymore and as such all agents in the new network have to define their connections with the new agent. This is achieved with a Gibbs sampler [6] based on the estimated parameters of the ERGM (see Table 1).

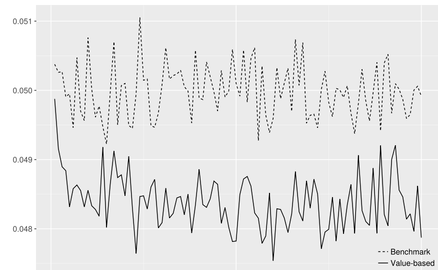
5 Results

To test our hypotheses, we have run the agent-based model for 100 steps.[10] Furthermore, 100 uniquely seeded repetitions were run to reduce stochastic noise and below we present the averaged (unweighted mean) results from these runs. The simulation outcomes for the selected parameter set are visualised in Figure 1. Exact numbers for the last step and means across all steps for the simulations of the benchmark and value-based models are shown in Table 6.

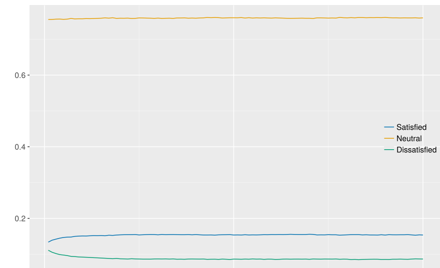
Figure 1a exhibits that the value-based model has higher stability (measured as a lower share of all agents changing their networks per simulation step)

[9] For now the δs are held constant at the above-mentioned values. However, in further studies we will consider δs as simulation parameters and run the model for their different values.

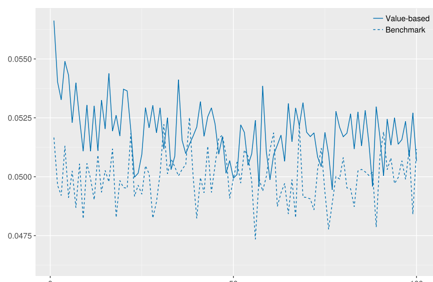
[10] Results from longer simulations did not yield any different dynamics or outcomes. Hence, the number of steps was kept to a low level that still allowed observation and discussion of the relevant trends and patterns.



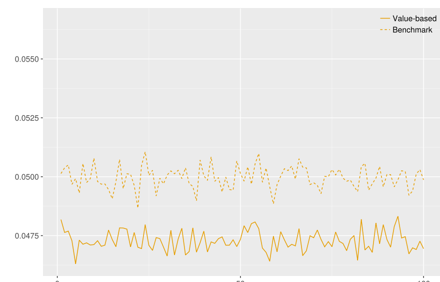
(a) Share of agents changing their networks per simulation step.



(b) Satisfaction levels as share of overall population per simulation step.



(c) Mean share of network changers among person-centred (O & SE) agents.



(d) Mean share of network changers among group-centred (C & ST) agents.

Fig. 1: Simulation results for benchmark (dashed lines) and Schwartz values based (solid lines) models. The data point right after model creation (i.e. step zero) has been omitted to increase plot readability since all agents are initialised with neutral satisfaction and not marked as changers.

throughout the whole simulation time when compared to the benchmark model. There is an early drop after approximately $10 - 15$ steps that leads to a more stable course of the curve which then oscillates around the 0.0485 mark until the end of the simulated timeframe. This observation correlates with a slight increase in the share of satisfied agents observable in Figure 1b which is simultaneously mirrored by a reduction in the share of dissatisfied agents. While the share of agents with neutral satisfaction stays at similar levels over the whole simulated period, such a stabilisation only occurs for the share of (dis-)satisfied agents after the initial phase of increased network change activity.

By breaking down the numbers presented in Figure 1a into the two groups of agents driven by person-centred (O & SE) and group-centred (C & ST) values, it is revealed that the former group is the driving force behind the aforementioned observations. Compared to the model with randomised behaviour, Figure 1c indeed exhibits significantly higher shares of agents changing their workgroups during each step. Figure 1d shows that the network changing activity of those agents driven by group-centred values is indeed lower than both in the person-centred group as well as the benchmark model. Furthermore, the curve is also less volatile and overall flatter throughout the whole simulation, pointing at a more constant development over time which can further be interpreted as a sign of network stability.

The signs of the relevant differences support both hypotheses H.1 and H.2 but the magnitude may be limited for the mean results. However, this weak impact of personal values on agent satisfaction with their current social network is in line with the empirical findings from a meta-study by [5], who described that personality (measured as self-monitoring and the Big Five traits) contributed only modestly to individuals' network positions. Given that the networks depicted in our model are fairly limited in scope and represent only informal aspects of a workplace, i.e. leaving aside the consideration of externally imposed hierarchies or required skillsets, the seemingly small observed variances in network stability should still be deemed noteworthy as one potentially significant factor of social networks in the workplace.

Table 6: Mean share of changers in % for benchmark and Schwartz values based models. The mean share of agents changing their networks is denoted by f and the subscript identifies the subpopulation of agents grouped by their higher order values (C, O, SE, ST) and by the aggregate level of person- and group-centredness (PC, GC).

	f	f_C	f_O	f_{SE}	f_{ST}	f_{PC}	f_{GC}
Benchmark	4.949	4.947	4.953	4.949	4.940	4.948	4.947
Value-based	4.791	5.118	4.784	5.165	4.579	5.141	4.682

6 Conclusions and Further Research

By the means of the constructed agent-based model we were unable to falsify our two research hypotheses. Indeed we could observe that agent behaviour based on individual Schwartz values provides greater stability of social networks at the workplace (comparing to the randomised benchmark networks). Further, agents driven by person-centred values (relating to the higher order value groups of Openness to Change and Self-Enhancement) change their social networks at the workplace more often than the agents driven by group-centred values (Conservation and Self-Transcendence). Hence, we can conclude that the preliminary results presented in this work indeed provide weak support for both proposed hypotheses.

As further research, we plan more systematic analyses of the model results for different parameter sets. Moreover, alternative decision rules both for social networks building and determination of satisfaction levels will be tested. In particular, satisfaction levels based on the relative position in the given social network will be proposed and verified. Furthermore, we will extend the simulation to other synthetic populations created from ESS9 data for different countries.

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