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Article

A matter of values: On the link between economic performance and Schwartz human values

Journal of Economics and Statistics

Provided in Cooperation with:

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Suggested Citation: Czupryna, Marcin; Schaff, Frederik (2024) : A matter of values: On the link between economic performance and Schwartz human values, Journal of Economics and Statistics, ISSN 2366-049X, De Gruyter Oldenbourg, Berlin, Vol. 244, Iss. 4, pp. 293-329, <https://doi.org/10.1515/jbnst-2023-0065>

This Version is available at:

<https://hdl.handle.net/10419/333286>

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A Matter of Values: On the Link Between Economic Performance and Schwartz Human Values

<https://doi.org/10.1515/jbnst-2023-0065>

Received August 29, 2023; accepted June 19, 2024

Abstract: The goal of the paper is to propose an abstract but formalised model of how Schwartz higher order values may influence individual decisions on sharing an individual effort among alternative economic activities. Subsequently, individual decisions are aggregated into the total (collective) economic output, taking into account interactions between the agents. In particular, we explore the relationship between individual higher order values: Self-Enhancement, Self-Transcendence, Openness to Change and Conservation – measured according to Schwartz’s universal human values theory – and individual and collective economic performance, by means of a theoretical agent based model. Furthermore, based on empirical observations, Openness to Change (measured by the population average in the case of collective output) is positively associated with individual and collective output. These relations are negative for Conservation. Self-Enhancement is positively associated with individual output but negatively with collective output. In case of Self-Transcendence, this effect is opposite. The model provides the potential explanations, in terms of individual and population differences in propensity for management, willingness to change and skills (measured by an educational level) for the empirically observed relations between Schwartz higher order values and individual and collective output. We directly calibrate the micro-level of the model using data from the ninth round of the European Social Survey (ESS9) and present the results of numerical simulations.

Keywords: agent-based modelling; Schwartz values; economic output

JEL Classification: E17; E27

Article Note: This article is part of the special issue “Advancing Agent-based Economics” published in the Journal of Economics and Statistics. Access to further articles of this special issue can be obtained at www.degruyter.com/jbnst.

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1 Introduction

We aim to provide a causal theoretical model that links Schwartz universal values to the individual behaviour and income and eventually to the collective output. Recent experiments point towards the notion that core values, as identified by Schwartz (1994, 2012), can be directly linked to cooperative behaviour. In particular, values may explain goal-oriented behaviours (Sagiv, Sverdlik, and Schwarz 2011). In a recent large scale meta-analysis of empirical studies, Rudnev, Magun, and Schwartz (2018) show that there is a positive correlation between more complex value structures (indicated by greater interdependence between the higher order values on the national scale) and economic performance (measured by gross national product per capita). There exists literature relating the Schwartz values and actions that may affect economic output, but the application is only limited to specific situations, individual choice (Roos 2018) or to specific environments – such as a fishery village (Heidari, Jensen, and Dignum 2020).

In the paper, we analyse the relation between the distribution of Schwartz higher order values in a population and an economic performance. Based on the descriptive interpretation of individual values in Schwartz (2012) and the results of the empirical analysis, we derive abstract mechanisms that may explain how socio-spatial connected individuals divide their working time among different economic activities. These mechanisms are used in the proposed agent-based model. An important characteristic of this model is that the aggregated social output depends on three factors: cooperation (propensity for management, willingness to change, in particular), individual effort (represented by skills and measured by educational level) and the distribution of Schwartz values in the populations. With respect to the first two factors, the relationships between them and both Schwartz values and individual economic output are empirically verified using data from the European Social Survey. The relation between distribution of Schwartz values in the population and the collective economic output is verified by the means of agent-based modelling.

In the remainder of this section, we discuss the theory underlying the most important assumptions and the mechanisms applied in the model. Firstly, we briefly introduce the Schwartz values theory. Secondly, we discuss the literature related to the group activity selection problem that provides the general abstract framework for our model. The biggest difference in our model is that we allow the agents to interact and self-organise. Thirdly, we discuss games that are used to represent the interactions among agents in literature. Finally, we discuss heuristics and related procedural/integrative processes as we deviate from the perfect rationality assumption in our model.

1.1 Values

In a recent and widely cited paper, Hoff and Stiglitz (2016) argue in favour of viewing the economic actor as an *enculturated actor*, i.e. making decisions according to worldviews rather than preferences.¹ We formalise the idea of enculturation using the Schwartz (Schwartz 1992, 1994, 2012) theory of individual human values, and considering these values as primary explanatory variables for economic activity in our model. Schwartz and his collaborators (Schwartz 1992, 1994, 2012) postulate that there are ten human values that are important for individual behaviour across all cultures. The Schwartz theory of values makes two central propositions, supported by empirical observations (Cieciuch et al. 2014; Schwartz and Boehnke 2004). Firstly, there is a structure of relations among values, which has the form of a circular continuum. This implies that the values that are close to each other are related to *compatible* motivations, whereas those values that lie on opposite sides of the circle are related to *conflicting* motivations. Secondly, individuals have a hierarchy of values. For each person, some values are more important than others. This determines how a person resolves potential conflicts between different Schwartz values. The individual values may be clustered into additional dimensions. One way to summarise the individual values is to define four higher order values (HVO) grouped by two kinds of two oppositional dimensions: self-transcendence opposed by self-enhancement and openness to change opposed by conservation, Schwartz (1992). By basing our approach on Schwartz's core values, we also benefit from their measurable, innumerable and universal nature (Table 1 and Figure 1).

1.2 Group Activity Selection Problems

In the classical group activity selection problem, the goal is to assign a group of agents to different sets of activities, see (Darmann et al. 2018, 2017; Lee and Williams 2017). An agent can be assigned to one task at most. The preferences of the agents may depend on different factors. (Darmann et al. 2018) consider the number of agents participating in a given activity as an example of such a factor. Ganian, Ordyniak, and Rahul (2018) consider agent heterogeneity by including agents of different types in

¹ Hoff and Stiglitz (2016) aim to broaden the economic discourse by discussing different conceptualisations of economic actors: the standard, preference-defined *rational actor*; the *quasi-rational actor*, enriched by insights from behavioural economics but still embracing an individualistic methodology; and the *enculturated actor*. The enculturated actor is distinguished from the first two categories by the idea of having multiple mental models that are shaped by social and personal environments and the experiences that the individual is exposed to. The actual decision then depends on which mental model gets activated.

Table 1: Schwartz values (Schwartz 2003, Table 1).

Value	Description
Universalism	Understanding, appreciation, tolerance and protection for the welfare of all people and for nature.
Power	Social status and prestige, control or dominance over people and resources.
Benevolence	Preservation and enhancement of the welfare of people with whom one is in frequent personal contact.
Achievement	Personal success through demonstrating competence according to social standards.
Conformity	Restraint of actions, inclinations and impulses likely to upset or harm others and violate social expectations or norms.
Stimulation	Excitement, novelty and challenge in life.
Tradition	Respect, commitment and acceptance of the customs and ideas that traditional culture or religion provide the self.
Hedonism	Pleasure and sensuous gratification for oneself.
Security	Safety, harmony and stability of society.
Self-direction	Independent thought and action choosing, creating and exploring.

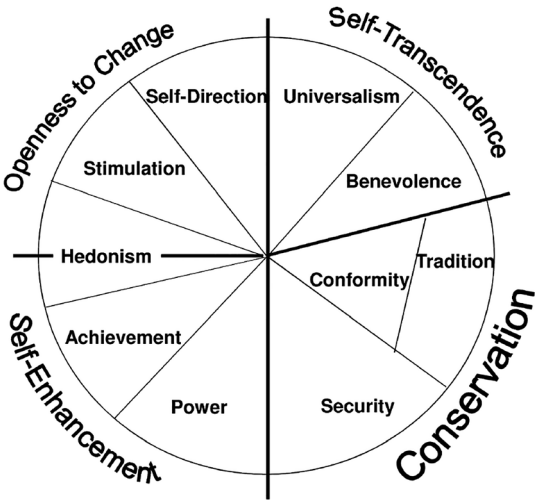


Figure 1: Schwartz's core values
Schwartz (2012).

the model. A similar problem, though in less abstract terms, is also considered in the economic literature. Rosen (1978) considers the problem of optimal allocation of workers having different skills to different tasks. The output depends on the set of workers having different skills available to complete a given task. The group activity selection problem is seen as a combinatorial problem in this field of study. The global optimum is sought from the perspective of a central planner. By contrast, in our

model, despite the similarities, we allow the agents to self-organise. Moreover, we do not assume perfect rationality on the part of agents.

1.3 Games

The complexity of economic activity and its resulting output is typically studied at a certain level of abstraction, for instance, by means of public goods games (Fehr and Gächter 2000) or trust games (Johnson and Mislin 2011). Public goods games feature the requirement of many economic outputs to be produced through team-work (joint production). While the group-level outcome of a public goods game depends on individuals' efforts and skills, the difficulty of measuring individual contributions effectively is most commonly represented by an even split of the outcomes. Thus, individuals have an incentive to not cooperate. Knack and Keefer (1997) show that trustworthy behaviour may lead to better economic outcomes. Besides the level of cooperation, the matching of heterogeneous agents is relative to determination of the productivity (see for example Angelovski et al. (2018)). This can be represented by adding a spatial dimension to the public goods games, allowing distance to determine interaction/matching probabilities (Nowak and May 1992), which allows the effects of different kind of networks to be tested (Choi, Kariv, and Gallo 2016).

An important piece of evidence from the literature on economic games is that human subjects in the lab do not follow the predictions of classical game theory (Henrich et al. 2001). Instead, there is a growing body of literature showing that value-based decisions may drive cooperation (Sagiv, Sverdluk, and Schwarz 2011; Tao and Au 2014), which can be implemented in formal (predictive) models by following psychological game theory (Azar 2019; Colman 2003; Geanakoplos, Pearce, and Stacchetti 1989), for instance. Notably, Mercuur, Dignum, and Jonker (2019) in a recent paper, using an agent-based approach (as we do), link Schwartz values to the actions taken of real human beings in an ultimatum game. Although the authors are not able to always reproduce the human subject behaviour with the theoretical simulation model based solely on values, they show that this approach is promising in that it explains behaviour quite good on the aggregate level and far better than an alternative model of economic behaviour, based on the traditional economic utility maximisation principles.

An important aspect of theoretical analysis of psychological game theory is that games are not 'solved' in the traditional way (backwards induction) but instead they are (forward) 'computed': The activities of the players reside on beliefs/experiences, which do not need to be coherent, although alternative analytical solution concepts exist (see, e.g. the JEBO special issue introduced in Dufwenberg and Patel 2019). In general, such an approach allows heterogeneity in behaviour and incomplete

knowledge. An early and most prominent example of a simulation model with heterogeneous agents and self-coordination properties is the El Farol Bar model (Arthur 1994), in which agents have heterogeneous sets of prediction models and act according to their past experience of how these models performed. We follow this strand of literature, further motivating our decision in the next section.

1.4 Heuristics

In general, economic models are based on ideas of *methodological individualism*, putting the individual economic actor at the centre of any explanatory model. This *Homo Economicus* is described as someone who has full awareness of:

why they do what they do, described as complete preferences over outcomes (Vanberg 2008),

how they select a given action from all possible actions, often termed complete rationality but perhaps better referred to as full optimisation or substantive rationality (Simon 1976, 1978) and

what they finally do, determined by the conditions under which they act, i.e. the personal endowments, environmental conditions and the expectations about what other actors will do, assuming (implicitly) rational expectations (Muth 1961) and common knowledge and rationality (Brandenburger and Dekel 1993).

A lot of the criticism of this traditional approach focuses on the inconsistency of theoretical predictions with actual observed behaviours and decisions, see Kahneman (2011), for example, who discusses the role of heuristics in decision making. Moreover, the *Homo Economicus* approach is concentrated on the representation of individuals and fails to account for their social relations or the consequences of individual decisions based upon them (Arrow 1994; Gintis 2000). A common critique levied at traditional economic models is that the individual knows too much about the game and other people (Simon 1990) speaks of *olympian rationality*, according to (Velupillai 2010).

In our theory, the individual is still an important cornerstone but is perceived as a constituent of the entire enveloping social network, acting on the basis of individual experiences.

Accordingly, we depart from the standard approach in all three dimensions:

why agents in our theory act in a specific way is determined by their Schwartz values and the inner goal to act in accordance with these values. This is in line with the idea of preferences over procedures (Vanberg 2008) and also loosely related to the idea of reduction of cognitive dissonance (Festinger 1954),

how agents act is captured through ideas of classical behavioural economics, where agents employ routines that make efficient use of the given knowledge and context, (Gersick and Hackman 1990; Kao and Velupillai 2015) and

what decisions agents make is determined by the relations that each agent has with other agents, the history of these relations and the personal capabilities of the agent in question. This combines evolutionary game theory in a spatial context (Nowak and May 1992) with ideas of heterogeneous strategies that are individually evaluated over time (e.g. Arthur 1994).

By departing from an optimisation strategy, we are able to actually model the decision-making process as a function of the past experiences of the specific individual. Thus, we are able to determine explicitly what each individual knows, based on the games they participated in at any specific point in time.

1.5 Integrative/Compensatory Decision Process

Often people are confronted with complex decisions in an uncertain environment. Such an environment renders optimisation practically impossible. In the literature, different models of learning are employed to model how people behave in such situations (Arifovic 1994; Arthur 1994; Brock and Hommes 1997; Dosi et al. 1999). Another approach assumes using explicit heuristics that do not belong to the class of reinforcement learning algorithms or *constructivist rationality* related ones but is instead based on ideas of *ecological rationality* (Smith 2003). Proponents of such an ecological rationality paradigm often study individual behaviour in very specific ways, i.e. using heuristics (Gigerenzer and Todd 1999; Gigerenzer and Selten 2001). The research on universal values shows that there is predictive power in those values which allow for the behaviour of individuals to be explained in fairly complex situations, i.e. in strategic games (Lönnqvist et al. 2013; Sagiv, Sverdlík, and Schwarz 2011). Accordingly, it should be possible to construct a set of competing rules for a given situation that corresponds to the dominance of certain values. The value portrait of an individual will then, in conjunction with the decision situation/environment, define the hierarchy and/or weight with which these rules are applied in order to reach a decision.

There are two basic ways in which such a strategic decision process can be modelled: procedural/non-compensatory and integrative/compensatory (Ayal and Hochman 2009).² In a non-compensatory approach, the result depends on the order

² We focus here on thoughtful decisions, i.e. decisions that would fall into the category of System 2 heuristics in the dual systems categorisation of Stanovich and West (2000). However, thoughtful decision-making does not necessarily imply a weighting approach. Often this is argued due to there being a false assumption that only integrative approaches can be optimal, and, underlying this

in which the individual decision criteria are applied (reducing the set of potential actions), whereas a compensatory decision process does not depend on the order in which the criteria are applied.

A typical example for the first type of non-compensatory strategies is the ‘Take-the-best, forget-the-rest’ heuristic, with discriminatory cues (Gigerenzer and Goldstein 1996).³ An agent defines a set of criteria that is suitable for excluding options and sorts them by priority (i.e. lexicographically). Then the agent iterates over this set of criteria, applying each criterion to the set of options until a single option remains. If a criterion removes all the remaining options, it is skipped. If all criteria have been processed and more than one option remains, a second heuristic is used. The successive application of ordered criteria was also proposed as an optimisation technique by Waltz (1967).

A typical example for the second type of compensatory heuristics is a traditional Bayes-tree. Consider the same set of discriminatory criteria as before. In a setting of risk, we can attribute unconditional probabilities to each criterion and, by aggregating the unconditional probabilities for each option through simple multiplication, define the total probability of success for each option (Anscombe and Aumann 1963; Savage 1954). The optimal option is then the one with the highest chance of success. In non-risky evaluations, the probabilities are exchanged with weights. For each option, the total weight is then the sum of those weights where the criterion has been fulfilled. Here, the optimal option is the one with the highest total weight. The application of decision weights for individual criteria was also proposed as an optimisation technique by Geoffrion, Dyer, and Feinberg (1972); Zionts and Wallenius (1976); Figueira et al. (2013).

In this work, we focus on the second type, integrative/compensatory strategies, allowing agents to decide on their activities based on all Schwartz higher order values at the same. Potentially different significance of four Schwartz higher order values is represented by decision weights.

In the next section, we present the results of the empirical analysis of the relations between Schwartz values and individual economic behaviour. These results form the basis for the mechanisms implemented in the agent-based model. Country level results are also presented in the same section. Then, in the following

assumption, the idea that optimality is defined by an outcome that can be maximised. As the bulk of research by the ABC-Research group shows, simple heuristics can often outperform complex (integrative) strategies and are also more descriptive (Marewski, Gaissmaier, and Gigerenzer 2010).
³ This heuristic is similar to the ‘elimination by aspects’ model from Tversky (1972), with the difference that the order of cues in Tversky’s model is probabilistic, whereas in the take-the-best heuristic, it is deterministic.

section, we detail the proposed agent-based model. Finally, we present and discuss the simulation results.

2 Empirical Data and Analysis

We used data from the ninth round of the European Social Survey (ESS9) to calibrate the model. We describe the data used and the results of the empirical analysis in a more detailed way later in this section.

2.1 Data

We used the following data from ESS database:

- 21-item human value scale, as developed by Schwartz (2003)
- sociological variable – level of education (*eisced*)
- economic variables: total hours normally worked per week in main job, overtime included (*wkhtot*), usual gross pay of the survey participant,⁴ (*grspnum*) and indirectly usual net pay of the survey participant, (*netinum*). The last two variables are only used for calibrating the model
- post-stratification weight (*pspwght*).

For each Schwartz value and participant, centred scores were calculated based on the ESS9 documentation. Firstly, the raw scores for the ten Schwartz values were calculated as the means of the relevant items. Secondly, an individual's mean score over all items was calculated. Thirdly, centred scores were obtained from the raw scores by subtracting the mean score. Finally, the Schwartz values are aggregated, using averages into higher order values (HOV): Self-Enhancement (Power, Achievement and Hedonism with a weight one half), Self-Transcendence (Universalism and Benevolence), Openness to Change (Stimulation Self-Direction, Achievement and Hedonism with a weight one half) and Conservation (Security, Conformity and Tradition).

We initially considered 47,086 observations. In the next step, we considered only participants of working age (greater than 17), with strictly positive number of total hours worked per week including overtime (based on the value of variable *wkhtot*) and having pay as a main source of income (the variable *fvzac* = 1). This further

⁴ Originally, the variable contains information about pay/pension/social benefits of the survey participant; however, finally, we only take the participants having pay as a main source of income into account.

reduced the number of observations down to 22,555. Additionally, after rejecting the incomplete cases with respect to all but pay related variables that were not directly used in the model, this number was further reduced to 22,125.⁵ The data covered 26 European countries: Austria (AT), Belgium (BE), Bulgaria (BG), Switzerland (CH), Czech Republic (CZ), Germany (DE), Estonia (EE), Spain (ES), Finland (FI), France (FR), Great Britain (GB), Croatia (HR), Hungary (HU), Ireland (i.e. Italy (IT), Lithuania (LT), Latvia (LV), Montenegro (ME), Holland (NL), Norway (NO), Poland (PL), Portugal (PT), Russia (RS), Sweden (SE), Slovenia (SI) and Slovakia (SK).

We decided to consider the information on gross pay (instead of net pay) to allow a comparison of results for countries with different tax and social security systems. In rare cases (7.37 %) of missing information about gross pay, but when the information about net pay was available, the missing information was imputed. We used country specific linear models considering both of the relevant variables (the average R squared coefficient for different countries' models was 67.7 %).

Additionally, in the final step, the original post-stratification weights are used to make the sample representative with respect to age group, gender and education. These weights correct for sampling and non-response errors.

2.2 Empirical Analysis

The results of the empirical analysis were used in the construction of the agent-based model, which is presented in the next section. The following factors/mechanisms: propensity for management, propensity to change occupation and skills (measured by the level of education) are agent-based model relevant. Therefore, we firstly present the empirically observed relations between Schwartz higher order values and these factors. Secondly, the correlation values between Schwartz higher order values and individual and collective output (measured by gross pay) are presented. The former are used to calibrate the model, and the latter to validate it.

2.2.1 Propensity for Management⁶

For the purpose of the econometric analysis, we assumed that managers are those participants, who are responsible for more than ten people in their jobs (based on the variable *njbspv*). Firstly, we compared the average gross pay for managers and non-

⁵ Initially, 22,440 observations were used in econometric analysis after removing cases with missing data for the variables *country* and *eiscd*. For other variables, observations with missing information were automatically excluded in the univariate analysis.

⁶ The role of managers (managing the activities, allocating of company resources) and their impact on economic performance is discussed in the literature, see Augier and Teece (2009).

Table 2: The impact of higher order values on being a manager.

Higher order value	Est. param. (1)	p Value (1)	Est. param. (2)	p Value (2)
Self-Enhancement	0.185	<0.001	0.249	<0.001
Self-Transcendence	−0.022	0.639	−0.156	0.001
Openness to Change	0.144	<0.001	0.168	<0.001
Conservation	−0.253	<0.001	−0.235	<0.001

managers in each country. The average difference was 57.30 % (with the standard deviation of 32.98 %) in favour of managers. Secondly, we compared the average working time for managers and non-managers in each country (based on variable *wkhtot* – total hours normally worked per week in main job overtime included). The average difference was 11.53 % (with the standard deviation of 8.88 %). Finally, we verified how the higher order values may influence the fact of being a manager. For this purpose, we estimated the parameters of the eight logistic regression models, with the relevant binary explanatory variable representing the fact of being the manager. To avoid the problem of multicollinearity, we estimated the four separate models for each HOV. In the first, four models (1) – used as a robustness verification – we only considered country as a control variable. The age and level of education were additional control variables in the remaining four models (2). The results are presented in Table 2. Both Self-Enhancement and Openness to Change increase the probability of becoming a manager (the former to a greater extent), whereas Self-Transcendence and Conservation decrease it (the latter to a greater extent).

2.2.2 Propensity to Change Occupation⁷

In the absence of other variables, the variable indicating whether the participant had paid work in another country, for the period more than 6 months and in the last 10 years (variable *wrkac6m*) was used as a proxy to determine the impact of the propensity to change job on a gross pay. As in the previous case, we firstly compared the average gross pay for those who have worked abroad and those who have not. The average difference was 28.36 % (with the standard deviation of 45.97 %) in favour of those who have worked abroad. Secondly, we verified how the higher order values may influence the propensity to change job. The results are presented in Table 3. Both Self-Enhancement and Openness to Change increase the propensity to change

7 De Lange, De Witte, and Notelaers (2008) identified work autonomy, engagement and departmental resources as predictors of the job change. Devereux and Hart (2006) show that different behaviour with respect to job changing or staying may lead to different wages.

Table 3: The impact of higher order values on propensity to change occupation.

Higher order value	Est. param. (1)	p Value (1)	Est. param. (2)	p Value (2)
Self-Enhancement	0.343	<0.001	0.420	<0.001
Self-Transcendence	−0.279	<0.001	−0.302	<0.001
Openness to Change	0.367	<0.001	0.441	<0.001
Conservation	−0.432	<0.001	−0.527	<0.001

occupation (with the latter to a greater extent), whereas Self-Transcendence and Conservation decrease it (with the latter to a greater extent).

2.2.3 Level of Education⁸

Level of education was measured according to European survey version of International Standard Classification of Education (ISCED). Seven categories are considered in this classification. The average gross pay in the second category (lower secondary) was 16.40 % (country specific standard deviation 43.15 %) higher than in the preceding category (less than lower secondary). Similarly, it was 23.35 % (33.80 %) in the third category (lower tier upper secondary), 1.20 % (18.22 %) in the fourth category (upper tier upper secondary), 22.20 % (35.16 %) in the fifth category (advanced vocational, sub-degree), 8.83 % (20.53 %) in the sixth category (lower tertiary education, BA level) and 26.18 % (17.68 %) in the last, seventh category (higher tertiary education, >= MA level). We observe that the higher the level of education, the higher is the gross pay. We also verified how higher order values may influence the level of education. The results are presented in Table 12 in the Appendix. All higher order values except Conservation are positively associated with the level of education.

2.2.4 Gross Pay

We also calculated the empirical Pearson correlations between Schwartz higher order values and usual gross income of the survey participant. Post-stratification weights were used as weights in the correlation analysis. The results are presented in Figure 2. Furthermore, Table 9 in Appendix A presents the raw values along with the means and standard deviations for each Schwartz higher order value. To conclude, we firstly observe that such Schwartz higher order values as Self-Enhancement and

⁸ The relation between educational level and income, in absolute and inequality contexts, is discussed in Gregorio and Lee (2002)

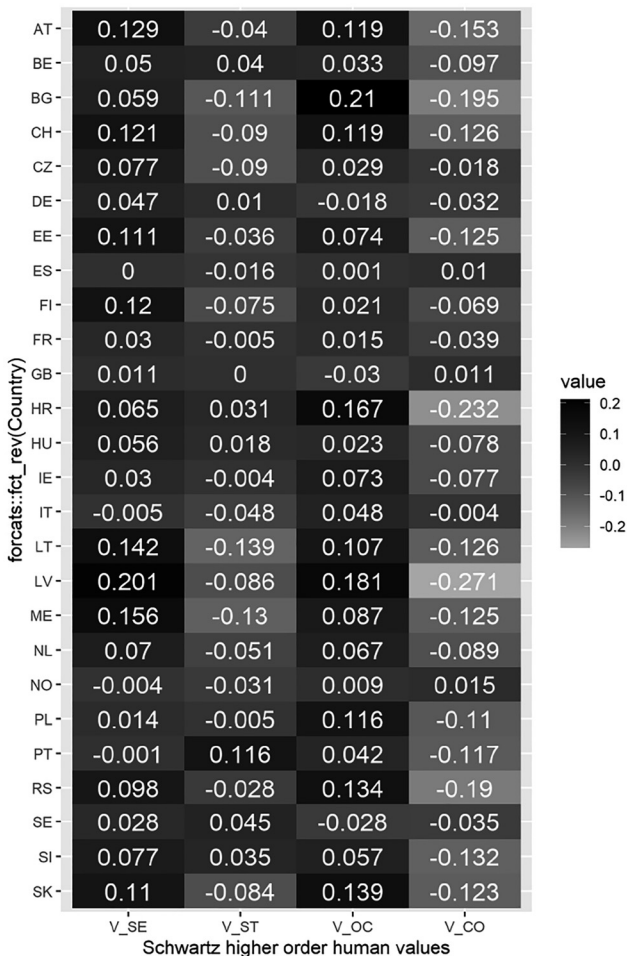


Figure 2: Empirical correlations between net income and Schwartz higher order human values per country. V_SE – Self-Enhancement, V_ST – Self-Transcendence, V_OC – Openness to Change, V_CO – Conservation.

Openness to Change generally exhibit positive correlation coefficients for all the countries. In contrast, the remaining Schwartz higher order values: Self-Transcendence and Conservation, show negative correlation coefficients. Secondly, the specific values of the correlation coefficients may vary among countries, and in some cases, they may even indicate a positive value for one country and a negative value for another.

Table 4: The correlation of higher order values with aggregated macroeconomic data: gross domestic product and Gini mean coefficient.

Higher order value	gdp cor. coeff.	gdp p value	Gini cor. coeff.	Gini p value
Self-Enhancement	−0.375	0.059	−0.131	0.550
Self-Transcendence	0.481	0.013	0.165	0.451
Openness to Change	0.426	0.030	−0.242	0.266
Conservation	−0.499	0.009	0.133	0.544

2.2.5 Country Level Results

The correlation results of the country specific averages of higher order values with Gross Domestic Product and Gini coefficient are presented in Table 4. We used the GDP per person employed (constant 2017 PPP USD) time series from the World Bank World Development Indicators database⁹ and Gini coefficient (2017 gross income, before taxes) for the working-age population from the OECD database.¹⁰ At the population level, unlike at the individual agent level, Self-Enhancement is negatively and Self-Transcendence is positively correlated with economic outcome (GDP). Self-Enhancement and Openness to Change show a negative correlation with the Gini coefficient, indicating lower income inequality. The opposite effect may be observed for Self-Transcendence and Conservation.

Similar results were obtained by Weckroth and Kemppainen (2016). They show the positive and statistically significant relation between Self-Direction (a Schwartz value that belongs to Openness to Change) and GDP per capita, and negative (statistically significant in some of the models presented in their paper) for Achievement and Power (Schwartz values that belong to Self-Enhancement) taking into account regional data.

3 Agent-Based Model

3.1 General Characteristics

The purpose of the model is to evaluate the link between the Schwartz higher order values and the aggregated economic performance. For this purpose, agents are created and located in geographical space (we use the notion of geographical

⁹ <https://databank.worldbank.org/source/world-development-indicators>

¹⁰ <https://stats.oecd.org/Index.aspx?DataSetCode=IDD>

distance in our model). A distinct agent population has been created for each of the 26 countries considered in the simulation, based on the results of the ESS9 survey. The primary agent characteristics include the following: 1) spatial coordinates, 2) the Schwartz values, 3) educational level and 4) the number of working hours. Each survey participant is represented by the given number of agents. We initialise the model by using the post-stratification weight, which gives the weight of a given agent in the sample used in ESS9. The exact number of agents corresponding to one participant in ESS9 is calculated by rounding the product of the post-stratification weight and the fixed number 3000. We choose 3000 as a heuristic trade-off balancing the accuracy of representation of the entire country population and the simulation run time. This number ensures sufficient representation of the whole population based on the weighted sample – rounding errors were negligible.¹¹ Additionally, each agent is characterised by two spatial coordinates (x , y) corresponding to the geographic coordinates. These coordinates were sampled uniformly, disregarding any effects of the actual (potentially non-uniform) within-country Schwartz values' distribution because of lack of the relevant data.

During each simulation step (we use 100 steps as this number is sufficient for the aggregate levels), an agent plays with its neighbours in a production game. There is no explicit time dimension for each step, and the results of the 100 steps are finally aggregated by taking the average. Firstly, agents decide whether they would like to organise the game (be a manager). If so, the agents invest their effort in their own game. Otherwise agents invest their total effort in the games of one of their neighbours. The neighbourhood is defined based on the Euclidean distance and the radius r , which is the simulation parameter. Secondly, the sum of all efforts collected by an agent is transformed into output, according to the agent-individual production function. Finally, the output is distributed among agents. The games are detailed in Section 3.2.

The consecutive phases of the simulation are enumerated below:

1. *Game selection*: Selection of one of the available games
2. *Production*: Produce the output
3. *Distribution*: Distribute the output among agents

In the first – game selection, the agents select a game they want to participate in, and invest all their efforts in such a game. In the second – production, the total effort of the agents is transformed into output according to the adopted production function.

¹¹ On one hand, the computer simulation took 24 hours, using two cores and parallel processing. On the other hand, the sizes of the synthetic populations did not differ by more than 5 % from the initially assumed value of 3000 (the minimum size was 2905 and the maximum 3129) and more than 99 % of ESS participants meeting the required criteria are considered in the simulation.

In the third – distribution, the output is distributed among all the agents proportionally to their effort.

The model is implemented in JAVA. The code is available at: <https://www.comses.net/codebases/c0b005bc-e6a4-49bd-894d-38cfefbc55284/releases/1.0.0/>.

3.2 Games

3.2.1 Production Function

In each round, agents play production games that involve transforming all the efforts (inputs) invested in agent i 's game into the output. The output is then distributed among all agents who invested in the game, in proportion to the effort they invested. The production function is given in Eq. (2). The symbol δ_i denotes the productivity factor of game i (the game hosted by an agent i), and the symbol e_i denotes the total effort invested in game i . The latter is the sum of the effort that agent i puts into its own game (e_i^0) multiplied by $\gamma > 1$, representing owner commitment factor and the efforts the other agents put into game i (e_i^j denotes the effort of agent j invested into agent i 's game), see Eq. (1). The variables β_1, β_2 are the simulation parameters.

$$e_i = \gamma e_i^0 + \sum_{j \neq i} e_i^j \quad (1)$$

$$y_i = \delta_i \times e_i^{\beta_1} \exp(\beta_2 e_i) \quad (2)$$

We use a transcendental production function (Halter, Carter, and Hocking 1957), as it allows for increasing, decreasing and negative marginal returns for different levels of input factors. It is more general than the classical Cobb-Douglas production function, which may be regarded as a special case of the transcendental production function. Therefore, it offers more flexibility. The usage of owner commitment factor primarily results from the observation that self-employed, managers or entrepreneurs are motivated more intrinsically and, therefore, work harder, see Section 2.2.

The productivity factor δ_i is determined in two steps. Firstly, we select a random number δ_i from the uniformly distributed random variable over the interval $(1 - \sigma, 1 + \sigma)$, where $\sigma < 1$ is a simulation parameter (half-range). Secondly, δ_i is additionally multiplied by the factor $\nu^{(s/100)}$, where the novelty factor ν is a simulation parameter and s is the number of this simulation step in which the game was first organised. The first step admits heterogeneity of the games and the second the technological progress. Eventually, the produced output is distributed among the agents in proportion to their efforts. The effort multiplied by the commitment factor is relevant for the calculation of the distribution for a game owner.

3.2.2 Rationality of the Agents

The agents make three types of decisions:

1. whether they want to organise a game,
2. which game they want to participate in,
3. whether they want to change the game they played in the previous simulation step.

The decisions are taken randomly; however, their probabilities may depend on the higher order values of the agents – in case of (1) and (3) – in a manner detailed in the next paragraphs.

We assume that agents, in their decisions, firstly consider the relevant decision variants, represented by the respective decision probabilities in the simulation, with respect to each Schwartz higher order value separately. Secondly, these partial intermediate probabilities are aggregated into the final one by weighting. By the term ‘rationality of integration’, we refer to the ways in which the weights for different values are calculated by an agent. We consider four different methods: 1) simple, 2) suppressed, 3) ranked and 4) non-linear decision weights. The first method is a baseline one, the second method corresponds to the original mechanism proposed by Schwartz for individual values, the third method provides an approximation of hierarchical decision process (with respect to Schwartz higher order values) and the last method represents the assumption of declining marginal importance of the higher order values.

In the first method, the weights (denoted by w_{SE} , w_{ST} , w_{OC} and w_{CO}) are calculated based on the relative importance – as measured by the human value scale – the higher order values, denoted m_v . The relative importance is calculated based directly on the ESS9 data, by rescaling such that the most important Schwartz values are assigned one and the least are assigned zero, see Eq. (3). The symbol m_v denotes maximum and $\underline{m_v}$ minimum value of m_v . If the higher order values were of equal importance to an agent, the same weights of 0.25 were assumed.

$$\frac{m_v - \underline{m_v}}{m_v - \underline{m_v}} \quad (3)$$

In the second method, an additional suppression mechanism is implemented. Specifically, it depends on the difference between the relative importance of the Schwartz higher order value m_v and its opposite Schwartz higher order value (with importance $m_{\phi(v)}$) – the weight is calculated according to Eq. (4). The constant 3 is determined based on the empirical distribution of the higher order values in the populations.

$$\frac{1}{1 + e^{-3(m_v - m_{\phi(v)})}} \quad (4)$$

In the third method, the weights are first ranked according to their relative importance, with ties being averaged. In cases where two or more values have the same weight, their final rank is calculated as the arithmetic average of the individual ranks. The most important value is assigned one. Then the weights are calculated as $1/2$ to the power of the rank and subsequently normalised.

In the last method, the weights are first transformed by the non-linear function, see Eq. (5) and subsequently normalised.

$$\frac{1}{1 + e^{-4.5m_v}} \quad (5)$$

The final probability of the event that an agent organises a game (p^O) is calculated according to Eq. (6).

$$p^O = w_{SE} \times p_{SE}^O + w_{ST} \times p_{ST}^O + w_{OC} \times p_{OC}^O + w_{CO} \times p_{CO}^O \quad (6)$$

The probabilities corresponding to higher order values: $p_{SE}^O > p_{OC}^O > p_{ST}^O > p_{CO}^O$ are the simulation parameters and the relationship between their values emerges from empirical analysis, see Table 2.

The final probability of the event that an agent considers changing a game (p^C) is calculated according to Eq. (7).

$$p^C = w_{SE} \times p_{SE}^C + w_{ST} \times p_{ST}^C + w_{OC} \times p_{OC}^C + w_{CO} \times p_{CO}^C \quad (7)$$

Similarly, the probabilities corresponding to higher order values: $p_{OC}^C > p_{SE}^C > p_{ST}^C > p_{CO}^C$ are the simulation parameters and the relationship between their values emerges from empirical analysis, see Table 3. Additionally, the probability p^C is divided by k (which is a simulation parameter) in case of the game owner, so that owners are less inclined to change their games.

The radius of an agent is also calculated in a similar way, see Eq. (8), where $r_{OC} > r_{SE} > r_{ST} > r_{CO}$ are the simulation parameters.

$$r = w_{SE} \times r_{SE} + w_{ST} \times r_{ST} + w_{OC} \times r_{OC} + w_{CO} \times r_{CO} \quad (8)$$

Upon deciding to consider changing the game, agents first determine whether they would like to organise their own games. In case they do not want to, agents join one of the all N games organised in their neighbourhood. Each of these games can be selected with the same probability $1/N$. In case no such games are available, agents invest in their own games, but the owner commitment factor γ is not considered in such a case.

3.2.3 Total Effort

We considered education to determine the total efforts of agents. Specifically, the initial total effort (equals 1 for all the agents) is additionally transformed using an agent's education level l^i , which is provided by ESS9, and the educational level scaling factor f_e , which is a simulation parameter. Specifically, the total effort by an agent is proportional to the educational level scaling factor raised to a power that is specified by educational level, denoted $l(i)$ for agent i . The total effort is thus calculated as $f_e^{l(i)-1}$. Based on the empirical results, we also combined the third (lower tier upper secondary education) and fourth (upper tier upper secondary education) categories into one.¹²

4 Simulation Results

The purpose of the simulation was to gain an understanding whether and to what extent the differences in the distribution of Schwartz higher order values in populations may explain differences between economic performance and income inequality. The answer to this question is not obvious, since some of the Schwartz higher order values (for example Self-Enhancement) leads to higher individual incomes for certain members of the population but may not necessarily lead to higher incomes across the whole population, and the converse may also apply (e.g. through altruistic behaviour). The verification that the Schwartz value differences lead to economic performance disparities was conducted in two steps. Firstly, we calibrated our theoretical model using the empirical correlation between Schwartz higher order values and usual gross income variables. This calibration was performed for all countries at once, i.e. assuming the same universal model.

Secondly, we conducted a sensitivity analysis. For this purpose, we constructed a set of synthetic populations by changing (decreasing and increasing) the importance of a given Schwartz higher order value in a population, for each agent separately. The populations constructed based on the EES9 data were the basis for the construction of the synthetic populations. Then, we calculated the economic

¹² We also initially considered other methods for the determination the total efforts of agents: (1) uniform, (2) working hours based and (3) education and working hours based. In the first method, each agent has the same value of the total effort, which is set to one in the simulation. In the second method, an agent's effort depends on a fraction resulting from the division of number of hours worked during the week by the standard number of working hours for a given country. In the last method, both working hours and level of education are considered. In this article, we have limited ourselves to presenting the results of only the method for which the best fit to the empirical data was obtained.

performance parameters – total economic performance and income inequality for the scenarios outlined – and compared the results with the base scenario. We describe the simulation parameters and results in a more detailed way later in this section.

4.1 Simulation Parameters

We executed the model separately for each country. The ranges for all the parameters determining agent behaviour are shown in Table 5. Furthermore, to systematically search the parameter space, we used 800 value sets determined by Sobol numbers (Bratley and Fox 1988; Christophe and Petr 2014). As the parameters are not directly observable (and thus unknown), we arbitrarily selected relatively wide ranges, additionally calibrated by the results of the preliminary simulation runs. We run the simulation for 26 country specific synthetic populations. In case of higher order values related parameters, we parametrised differences between parameters

Table 5: Parameter ranges.

Parameter	Name	Lower value	Upper value
γ	Owner commitment factor	1.3	2.0
β_1	Production function (total effort)	3.0	5.0
β_2	Production function (total effort)	−0.07	−0.02
σ	Productivity half-range	0.0	0.3
ν	Novelty factor	1	1.1
k	Owner propensity to change factor	1.0	2.0
p_{CO}^O	Probability of game ownership Conservation	0.025	0.1
$p_{ST}^O - p_{CO}^O$	Δ probability of game ownership Self-Transcendence	0.0	0.025
$p_{OC}^O - p_{ST}^O$	Δ probability of game ownership Openness to Change	0.025	0.05
$p_{SE}^O - p_{OC}^O$	Δ probability of game ownership Self-Enhancement	0.0	0.1
p_{CO}^C	Probability of game change Conservation	0.05	0.10
$p_{ST}^C - p_{CO}^C$	Δ probability of game change Self-Transcendence	0.0	0.025
$p_{SE}^C - p_{ST}^C$	Δ probability of game change Self-Enhancement	0.05	0.125
$p_{OC}^C - p_{SE}^C$	Δ probability of game change Openness to Change	0.0	0.075
r_{CO}	Radius Conservation	0.025	0.05
$r_{ST} - r_{CO}$	Δ radius Self-Transcendence	0.0	0.025
$r_{SE} - r_{ST}$	Δ radius Self-Enhancement	0.025	0.05
$r_{OC} - r_{SE}$	Δ radius Openness to Change	0.0	0.025
f_e	Educational level scale	1.075	1.175

for two different higher order values rather than the absolute values. In such a way, we accounted for the empirical relationships between values and observable behaviours, shown in Tables 2 and 3.

We also considered four variants of rationality of integration (decision weights): simple, suppressed, ranked and non-linear; one variant of pay-off distribution: proportional to the invested effort and finally, one variant of the total effort determination: education based. We ran 2 simulations for each parameter set with different seeds, which led to $166,400 = 800 \times 26 \times 4 \times 1 \times 1 \times 2$ simulation runs in total. Each simulation run consisted of 100 simulation steps.

4.2 Calibration

The characteristics of the calibration and the subsequent sensitivity analysis are related to the explanatory nature of this model, with the objective being to show that the connection between Schwartz higher order values and macroeconomic variables can be made. We used empirical Pearson correlations between Schwartz higher order values and usual gross income for different countries for the calibration of the model, see Table 9 in Appendix A. Furthermore, based on the simulation data, we calculated the Pearson correlations between Schwartz values and the agent's total income based on the entire agents' population, for each country and each parameter set separately. We used an agent's total income, which was calculated as the mean value for the results for two different seeds.¹³ The observed differences between empirical and simulation-based correlations were summarised using root mean squared error (RMSE) for each set of parameters.

Finally, calibration was conducted in two steps. In the first step, we calculated the average RMSE for each of four different decisions weights: simple (0.100), suppressed (0.127), ranked (0.0829) and non-linear (0.113), and chose the one with the smallest error. In the second step, we selected the one global parameter set (i.e. the same for each country) for which the squared difference between empirical and simulation-based correlations is minimal.

The values of the optimal parameter set (from the 3200) are as follows: rationality = hierarchical, total effort = education based, $\gamma = 1.671$, $\beta_1 = 4.199$, $\beta_2 = -0.053$, $\sigma = 0.008$, $\nu = 1.039$, $k = 1.654$, $p_{CO}^O = 0.056$, $p_{ST}^O = 0.08$, $p_{OC}^O = 0.106$, $p_{SE}^O = 0.182$, $p_{CO}^C = 0.051$, $p_{ST}^C = 0.052$, $p_{SE}^C = 0.108$, $p_{OC}^C = 0.151$, $r_{CO} = 0.033$, $r_{ST} = 0.04$, $r_{SE} = 0.067$, $r_{OC} = 0.076$, $f_e = 1.08$.

The neoclassical production function, for the optimal set of parameters and the total effort values ranging from 0 to 500, is presented the left (a) panel of Figure 3. For

¹³ The differences between results for different seeds are insignificant.

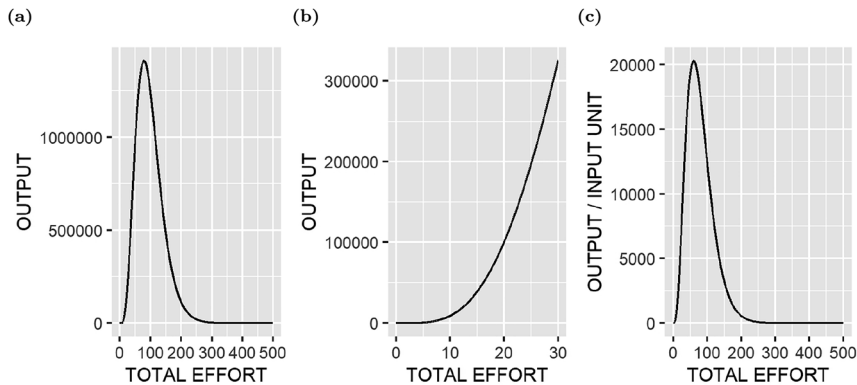


Figure 3: Production function for calibrated parameters.

the total effort value of 500, the output value is close to 0. The values of the output, but only for the simulation relevant range (the typical values of the total effort were included in this range during the simulation), are presented in the middle (b) panel. We can observe that the product is increasing and convex for this range. The normalised output, namely the output per unit of an effort, is presented in the right (c) panel. We use a different scale on each graph to improve readability.

The empirical Pearson correlations (Schwartz values and income) for different countries are presented as a heat map in Figure 4, and additionally in Table 10 in Appendix A.

We have also calculated the correlations between collective income for each of the 26 populations and the average numerical value of the Schwartz higher order value in a given population, and the results are shown in Table 6. At the level of the population, Self-Enhancement is negatively and Self-Transcendence is positively correlated with economic outcome (GDP). Self-Enhancement and Openness to Change is negatively correlated with Gini coefficient (associated with lower income inequality). Opposite effect may be observed for Self-Transcendence and Conservation. Such results correspond to the empirical observations.

For the validation purposes, we calculated Pearson correlations between simulated and empirical gross domestic product (collective output) and Gini coefficients for different countries. Both correlations coefficients were positive 0.40 ($n = 26$, p value = 0.043) in case of collective output measures, and 0.38 ($n = 23$, p value = 0.072) in case of Gini coefficients.

The differences between simulated and empirical Pearson correlations (Schwartz values and income) for different countries are presented as a heat map in Figure 5, and additionally in Table 11 in the Appendix. The mean absolute difference

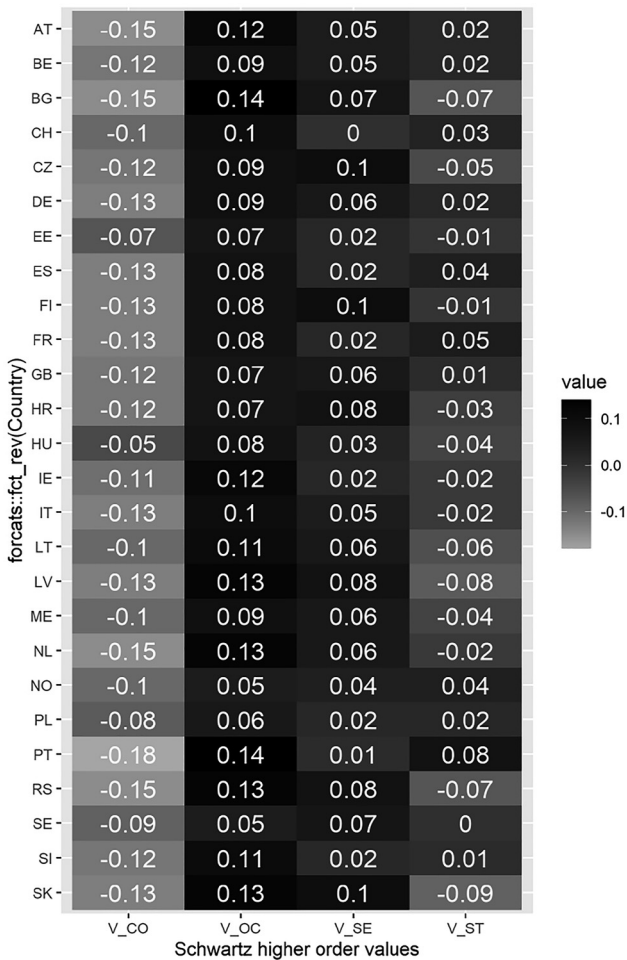


Figure 4: Simulated correlations between net income and Schwartz’s human values per country. V_SE – Self-Enhancement, V_ST – Self-Transcendence, V_OC – Openness to Change, V_CO – Conservation.

Table 6: The correlation of higher order values with aggregated macroeconomic data: gross domestic product and Gini mean coefficient.

Higher order value	gdp cor. coeff.	gdp p value	Gini cor. coeff.	Gini p value
Self-Enhancement	−0.65	0.0003	−0.12	0.5489
Self-Transcendence	0.65	0.0004	0.10	0.6362
Openness to Change	0.45	0.0216	−0.60	0.0013
Conservation	−0.41	0.0376	0.47	0.0150

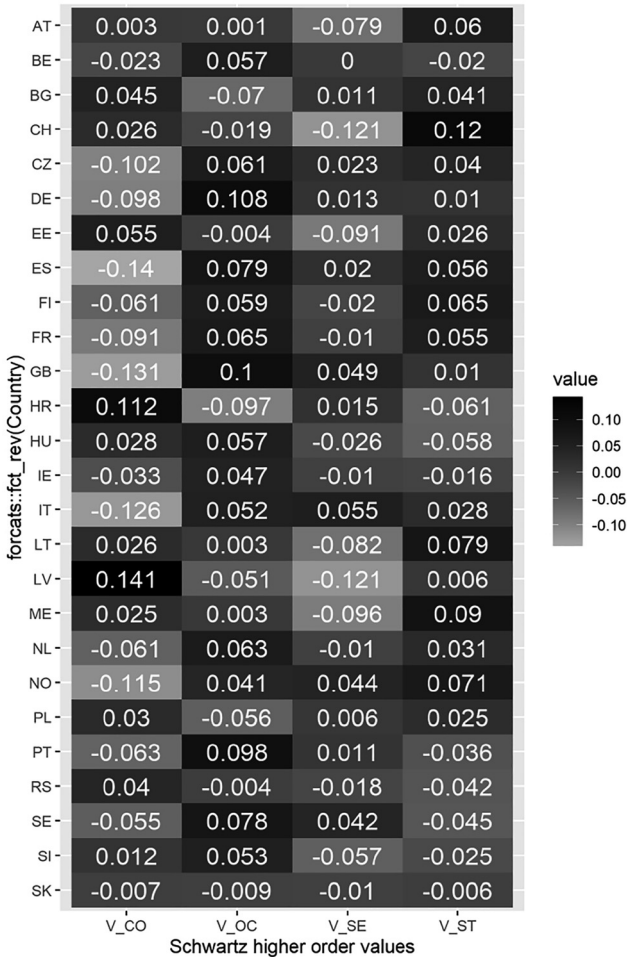


Figure 5: Differences between empirical and simulated correlations between net income and Schwartz human values per country. V_SE – Self-Enhancement, V_ST – Self-Transcendence, V_OC – Openness to Change, V_CO – Conservation.

for all countries and the Schwartz higher order values amounts to 0.052. It may partly result from the relatively high differentiation of the correlations by country and the abstract character of the model. Since we did not define individual parametrisations per country, structural differences that are not reflected in the different geospatial Schwartz values' distributions (from ESS9 data) will contribute to these differences, too.

4.3 Sensitivity Analysis

We conducted two types of sensitivity analysis for the obtained results. Firstly, based on different simulation parameter values, and secondly, considering the distribution of Schwartz higher order values in the population.

The regression analysis was conducted in two steps. Firstly, we fitted the generalised additive model, Wood (2004, 2011) to identify potential non-linear relations between explanatory variables (gross output and Gini’s coefficient) and different parameter values. Such a non-linear relationship was identified for the gross output and the following parameters: β_1 and β_2 – production function parameters and p_{CO}^C – probability of game change for Conservation. Secondly, we fitted linear regression models with additional squared terms for these three parameters. The results are presented in Table 7 for the mean output and Table 8 for the Gini coefficient.

Table 7: The relationship between mean gross output and parameters’ values.

Parameter	Parameter name	Estimate	Std. Error	t Value	Pr(> t)
	Intercept	0.6475	0.0114	56.5830	0.0000
γ	Owner commitment factor	0.0066	0.0007	9.1801	0.0000
β_1	Production function (total effort)	−0.4470	0.0039	−114.7075	0.0000
β_1^2	sq. production function (total effort)	0.0623	0.0005	128.1798	0.0000
β_2	Production function (total effort)	0.7501	0.0705	10.6436	0.0000
β_2^2	sq. production function (total effort)	3.6483	0.7754	4.7052	0.0000
σ	Productivity half-range	0.0078	0.0017	4.6820	0.0000
ν	Novelty factor	0.0331	0.0050	6.6049	0.0000
k	Owner propensity to change factor	−0.0122	0.0005	−24.3006	0.0000
p_{CO}^O	Probability of game ownership Conservation	−1.4482	0.0437	−33.1173	0.0000
$p_{ST}^O - p_{CO}^O$	Δ probability of game ownership Self-Transcendence	7.4061	0.3454	21.4421	0.0000
$p_{OC}^O - p_{ST}^O$	Δ probability of game ownership Openness to Change	−0.4427	0.0201	−22.0743	0.0000
$p_{SE}^O - p_{OC}^O$	Δ probability of game ownership Self-Enhancement	−0.1233	0.0199	−6.1911	0.0000
p_{CO}^C	Probability of game change Conservation	−0.0383	0.0050	−7.6362	0.0000
$(p_{CO}^C)^2$	sq. probability of game change Conservation	0.0229	0.0100	2.2898	0.0220
$p_{ST}^C - p_{CO}^C$	Δ probability of game change Self-Transcendence	−0.1293	0.0200	−6.4650	0.0000
$p_{SE}^C - p_{ST}^C$	Δ probability of game change Self-Enhancement	0.0189	0.0067	2.8225	0.0048
$p_{OC}^C - p_{SE}^C$	Δ probability of game change Openness to Change	−0.0332	0.0094	−3.5267	0.0004
r_{CO}	Radius Conservation	0.4146	0.0200	20.7120	0.0000
$r_{ST} - r_{CO}$	Δ radius Self-Transcendence	0.2888	0.0200	14.4162	0.0000
$r_{SE} - r_{ST}$	Δ radius Self-Enhancement	0.0733	0.0200	3.6617	0.0003
$r_{OC} - r_{SE}$	Δ radius Openness to Change	0.0498	0.0281	1.7692	0.0769
f_e	Educational level scale	0.1700	0.0050	33.9026	0.0000

Table 8: The relationship between Gini coefficients and parameters' values.

Parameter	Parameter name	Estimate	Std. error	t Value	Pr(> t)
	Intercept	−0.3686	0.0127	−28.9949	0.0000
γ	Owner commitment factor	−0.0064	0.0011	−5.7426	0.0000
β_1	Production function (total effort)	0.1668	0.0004	430.0770	0.0000
β_2	Production function (total effort)	2.8668	0.0155	184.9340	0.0000
σ	Productivity half-range	0.0274	0.0026	10.6029	0.0000
ν	Novelty factor	0.0303	0.0078	3.9070	0.0001
k	Owner propensity to change factor	0.0013	0.0008	1.7139	0.0865
p_{CO}^O	Probability of game ownership Conservation	−0.5722	0.0103	−55.3490	0.0000
$p_{ST}^O - p_{CO}^O$	Δ probability of game ownership Self-Transcendence	−0.5994	0.0310	−19.3386	0.0000
$p_{OC}^O - p_{ST}^O$	Δ probability of game ownership Openness to Change	−0.0543	0.0308	−1.7620	0.0781
$p_{SE}^O - p_{OC}^O$	Δ probability of game ownership Self-Enhancement	−0.0731	0.0078	−9.4133	0.0000
p_{CO}^C	Probability of game change Conservation	−1.7265	0.0155	−111.4160	0.0000
$p_{ST}^C - p_{CO}^C$	Δ probability of game change Self-Transcendence	−1.2173	0.0309	−39.3575	0.0000
$p_{SE}^C - p_{ST}^C$	Δ probability of game change Self-Enhancement	−0.4908	0.0103	−47.4870	0.0000
$p_{OC}^C - p_{SE}^C$	Δ probability of game change Openness to Change	0.1617	0.0146	11.0938	0.0000
r_{CO}	Radius Conservation	−4.8753	0.0310	−157.5015	0.0000
$r_{ST} - r_{CO}$	Δ radius Self-Transcendence	−3.5585	0.0310	−114.8627	0.0000
$r_{SE} - r_{ST}$	Δ radius Self-Enhancement	−1.4616	0.0309	−47.2359	0.0000
$r_{OC} - r_{SE}$	Δ radius Openness to Change	0.6337	0.0435	14.5674	0.0000
f_e	Educational level scale	0.5632	0.0078	72.6160	0.0000

Generally speaking, the following parameters: β_1 , β_2 , f_e , and all radius-related parameters increase the gross output. The probability of game change p_{CO}^C rather reduces the gross output. The impact of probabilities of game ownership for different higher order values is ambiguous (Table 8).

The following parameters: β_1 , β_2 and f_e increase the Gini coefficients, indicating higher inequality. As a tendency, probability of game ownership, probability of game change and radius-related parameters decrease the Gini coefficients.

We also conducted a sensitivity analysis with respect to the distribution of Schwartz higher order values in the observed populations. Firstly, we constructed a set of synthetic populations by changing (decreasing and increasing) the importance of a given Schwartz higher order value in a population, and additionally selected

pairs of higher order values simultaneously, for each agent separately. The Schwartz higher order values were changed each time by adding a constant:

$$\Delta \in \{-2.0, -1.5, -1.0, -0.75, -0.5, -0.4, \dots, 0.4, 0.5, 0.75, 1.0, 1.5, 2.0\}$$

The marginal values of -2 (2) make all individual agents have the least (respectively the most) important higher order value equal the stressed value. Finally, the new values are adjusted in such a way that the corresponding decision weights remain in the range $[0,1]$. We then calculated the economic performance parameters – total economic performance as measured by gross output and income inequality – for the scenarios under analysis and compared the results with the base scenario. The results for total economic performance (as measured by aggregate income) and higher order values, averaged for all 26 countries, are presented in Figure 6. The baseline results are represented by the horizontal dashed red line in the respective figures.

We can observe non-linear relations between gross output and higher order values. The effect with the greatest magnitude is observed for Self-Enhancement and is negative. The fact that Self-Enhancement reduces cooperation between agents may explain this observation. The effect for Openness to Change is non-monotonic first increasing and then, for the significantly positive stress factors, decreasing. This non-monotonic relation may suggest the potential conflict between self-interest and common interests. Furthermore, we can also observe that a higher level of Conservation (*ceteris paribus*) corresponds with an increased collective output. However, the empirical data show the opposite relationship, see Table 4. One potential reason could be the negative correlation of the Conservation with education level, which is indirectly accounted for in the empirical data, but not in the simulation.

The results for total economic performance and the pairs of higher order values, averaged for all 26 countries, are presented in Figure 7.

Similarly, we can observe non-linear relations between gross output and higher order values. The effect with the greatest magnitude is observed for the pairs

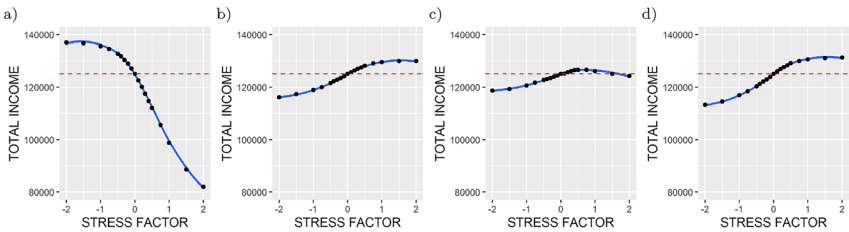


Figure 6: Total economic gross income of the population and the Schwartz higher order human values. (a) Self-Enhancement, (b) Self-Transcendence, (c) Openness to Change and (d) Conservation.

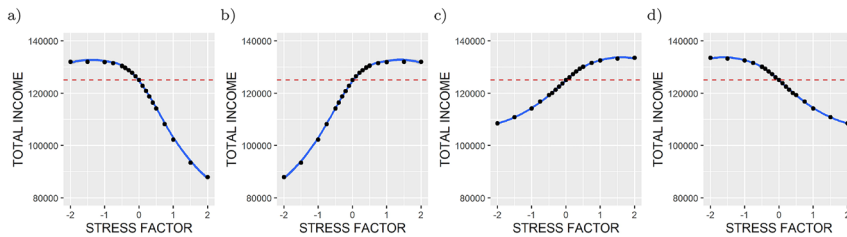


Figure 7: Total economic gross income of the population and the pairs of Schwartz higher order human values. (a) Self-Enhancement & Openness to Change, (b) Self-Transcendence & Conservation, (c) Self-Transcendence & Openness to Change and (d) Self-Enhancement & Conservation.

Self-Enhancement and Openness to Change (negative, but irrelevant for significantly negative stress factors) and Self-Transcendence and Conservation (positive, but irrelevant for significantly positive stress factors).

The results for income inequality, averaged for all 26 countries, are presented in Figure 8. We measure income inequality by means of Gini's coefficient.

We can observe non-linear relations between economic inequality and higher order values. Self-Enhancement and Openness to Change decrease Gini coefficient, while Self-Transcendence and Conservation increase it. This may be explained by the higher total number of games available in the local neighbourhood (higher probability of game ownership and larger radius), more frequent game changes by the agents in the former case and the opposite effect in the latter.

The results for economic inequality and the pairs of higher order values, averaged for all 26 countries, are presented in Figure 9.

Similarly, we can observe non-linear relations between Gini's coefficients and higher order values. The effect with the greatest magnitude is observed for the pairs: Self-Enhancement and Openness to Change (negative) and Self-Transcendence and

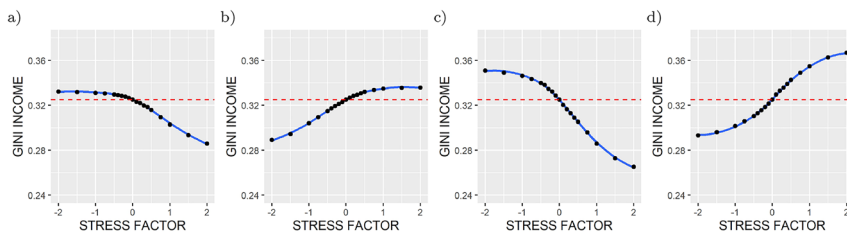


Figure 8: Gini's coefficients for the economic gross income of the population and the Schwartz higher order human values. (a) Self-Enhancement, (b) Self-Transcendence, (c) Openness to Change and (d) Conservation.

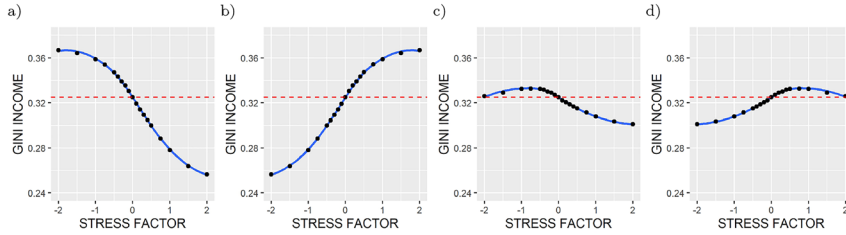


Figure 9: Gini's coefficients for the economic gross income of the population and the pairs of Schwartz higher order human values. (a) Self-Enhancement & Openness to Change, (b) Self-Transcendence & Conservation, (c) Self-Transcendence & Openness to Change and (d) Self-Enhancement & Conservation.

Conservation (positive) as the similar effects of both higher order values in a given pair accumulate. The non-monotonic relation observed for the two remaining pairs: Self-Transcendence and Openness to Change and Self-Enhancement and Conservation may be explained by the fact opposite individual effects of both higher order values in a given pair cancel out.

5 Conclusions

We proposed an abstract and relatively simple model that formalises how Schwartz higher order values can influence the aggregated societal economic output. For this purpose, we began by representing social production in the form of simple games played between agents. The individual decisions concerning game strategy are guided by the Schwartz values. The following aggregation of the game results allows both micro and macro perspectives to be combined.

The model provides the potential explanations for the observed empirical correlations between Schwartz higher order values and individual and collective economic output. These potential explanations correspond to the behavioural mechanisms implemented in the model, including becoming a manager and changing an occupation. These mechanisms depend on propensities for management and changing occupation, which are associated with Schwartz higher order values. Additionally, we consider the level of education as a simulation parameter and model its impact on agents' productivity. In particular, Openness to Change (measured by the population average in case of the collective case) is positively associated with both individual and collective output, Conservation is negatively associated with individual and collective output, Self-Enhancement is positively associated with individual output but negatively with collective and finally Self-Transcendence is negatively associated with individual output but positively

with a collective one. Openness to Change increases the propensity for management (though to a lesser extent than Self-Enhancement) and for changing occupation (to a higher extent than Self-Enhancement), and it is positively associated with the level of education. Conservation decreases both the propensity for management and for changing occupation (to a higher extent than Self-Transcendence), and it is also negatively associated with the level of education. Self-Enhancement increases the propensity for management and for changing occupation, and it is positively associated with the level of education. Self-Transcendence decreases the propensity for management and for changing occupation, but it is positively associated with the level of education. The model may also provide the explanation for the counter-intuitive observation that the higher level of Self-Enhancement (measured as the average value in the population) leads to lower income inequality, by taking into account interactions between agents from the populations with different Schwartz value distributions.

Two alternative models of the decision process: integrative/compensatory and procedural/non-compensatory are discussed in the literature. We have only considered the former in our model, since it allowed for decomposition with respect to individual Schwartz higher order values. Such decomposition facilitated representation of a decision process guided by the Schwartz values. For the final aggregation, we considered four alternative mechanisms in our model. The mechanism that assumes hierarchy (rank) of the Schwartz higher order values led to the best fit for the empirical data. We also proposed a simple mechanism: game strategies in the form of ideal vectors. An ideal vector is an abstract representation of the possible game strategy 'optimal' with respect to an individual Schwartz human value. Optimal here is not related to the expected output (income) but to adhering to the behaviour rules associated with the respective values. These representations were derived based on the general description of the human values and the results of the empirical analysis, with the intention of capturing the overall characteristics of a given human value and the differences among them. We do admit that this approach is, to a certain extent, subjective (even, if the individual mechanisms implemented in the proposed model have their justification in the literature and empirical results) and may constitute a limitation to our model. However, in the absence of high quality experimental data, no other approach was possible. Although using a procedural/non-compensatory approach is possible, it requires prior experimentation in order to ascertain the details of how an appropriate decision model could be constructed.

We propose simple mechanisms that may explain the causal relation between human values and economic performance, controlling for the level of education. We do not take into account other individual characteristics, such as skills other

than measured by the level of education, employment, industry sectors or other economic variables (e.g. capital, available technology, monetary transfers) that may also influence the observed empirical correlations between Schwartz's human higher order values and gross pay. Taking into account these mechanisms may constitute an extension of the proposed model.

By using the agent-based modelling approach, we have implicitly accepted the causal relation between Schwartz higher order values and the economic performance. However, the relation in the other direction – for example higher income levels may result in greater importance of Openness to Change – is possible, as the values may change as a result of life-transition and early socialisation, Bardi et al. (2014). On the other hand, values remain relatively stable during an individual's lifetime, Bardi and Goodwin (2011), and highly resistant to change Brewer and Roccas (2001).

The simplicity of the current model may be considered a desirable attribute for an initial exploration of the link between Schwartz higher order values and economic performance, but it also allows for further improvements in future research. One strand of research could focus directly on gaining better insights into how values can be related to individual strategies in the proposed kind of game. Another strand of research could focus on the effects of the spatial distribution of the values, which we have taken for granted but not analysed with counterfactual experiments or differences between the countries. Finally, it would be interesting to see if a more myopic implementation of the agents knowledge/experiences, i.e. where agents make personal experiences and cannot observe all outcomes, would have positive effects on the ability of the model to fit the empirical analysis. It is reasonable to anticipate that such an approach would alter the way the agents organise themselves among the potential games.

6 Acknowledgements

We thank Bogumił Kamiński and Michael Roos for discussions and all valuable comments. We also thank the attendees of the 2019 Social Simulation Conference held in Mainz for all the remarks and suggestions. We would also like to thank Timothy Harrell for his advice concerning matters of English usage. We are also thankful to the two anonymous reviewers for their insightful comments and suggestions. This research was supported by a grant awarded by the National Science Centre of Poland under the project title 'Values and Economic Performance: A formalised agent-based model' Decision no. 2018/31/G/HS4/01,040.

Appendix A

Table 9: Empirical Pearson correlations between Schwartz higher order values and usual gross income for different countries.

Country	V_SE	V_ST	V_OC	V_CO
AT	0.129	−0.040	0.119	−0.153
BE	0.050	0.040	0.033	−0.097
BG	0.059	−0.111	0.210	−0.195
CH	0.121	−0.090	0.119	−0.126
CZ	0.077	−0.090	0.029	−0.018
DE	0.047	0.010	−0.018	−0.032
EE	0.111	−0.036	0.074	−0.125
ES	0.000	−0.016	0.001	0.010
FI	0.120	−0.075	0.021	−0.069
FR	0.030	−0.005	0.015	−0.039
GB	0.011	0.000	−0.030	0.011
HR	0.065	0.031	0.167	−0.232
HU	0.056	0.018	0.023	−0.078
IE	0.030	−0.004	0.073	−0.077
IT	−0.005	−0.048	0.048	−0.004
LT	0.142	−0.139	0.107	−0.126
LV	0.201	−0.086	0.181	−0.271
ME	0.156	−0.130	0.087	−0.125
NL	0.070	−0.051	0.067	−0.089
NO	−0.004	−0.031	0.009	0.015
PL	0.014	−0.005	0.116	−0.110
PT	−0.001	0.116	0.042	−0.117
RS	0.098	−0.028	0.134	−0.190
SE	0.028	0.045	−0.028	−0.035
SI	0.077	0.035	0.057	−0.132
SK	0.110	−0.084	0.139	−0.123
avg.	0.069	−0.030	0.069	−0.097
sd	0.055	0.060	0.065	0.075

V_SE – Self-Enhancement, V_ST – Self-Transcendence, V_OC – Openness to Change, V_CO – Conservation.

Table 10: Simulated Pearson correlations between Schwartz higher order values and typical gross income for different countries.

Country	V_SE	V_ST	V_OC	V_CO
AT	0.050	0.020	0.120	−0.150
BE	0.050	0.020	0.090	−0.120
BG	0.070	−0.070	0.140	−0.150
CH	0.000	0.030	0.100	−0.100
CZ	0.100	−0.050	0.090	−0.120
DE	0.060	0.020	0.090	−0.130
EE	0.020	−0.010	0.070	−0.070
ES	0.020	0.040	0.080	−0.130
FI	0.100	−0.010	0.080	−0.130
FR	0.020	0.050	0.080	−0.130
GB	0.060	0.010	0.070	−0.120
HR	0.080	−0.030	0.070	−0.120
HU	0.030	−0.040	0.080	−0.050
IE	0.020	−0.020	0.120	−0.110
IT	0.050	−0.020	0.100	−0.130
LT	0.060	−0.060	0.110	−0.100
LV	0.080	−0.080	0.130	−0.130
ME	0.060	−0.040	0.090	−0.100
NL	0.060	−0.020	0.130	−0.150
NO	0.040	0.040	0.050	−0.100
PL	0.020	0.020	0.060	−0.080
PT	0.010	0.080	0.140	−0.180
RS	0.080	−0.070	0.130	−0.150
SE	0.070	0.000	0.050	−0.090
SI	0.020	0.010	0.110	−0.120
SK	0.100	−0.090	0.130	−0.130
avg.	0.051	−0.010	0.097	−0.119
sd	0.029	0.044	0.027	0.028

V_SE – Self-Enhancement, V_ST – Self-Transcendence, V_OC – Openness to Change, V_CO – Conservation.

Table 11: The differences between simulated and empirical Person correlations (Schwartz higher order values and usual gross income) for different countries.

Country	V_SE	V_ST	V_OC	V_CO
AT	−0.079	0.060	0.001	0.003
BE	0.000	−0.020	0.057	−0.023
BG	0.011	0.041	−0.070	0.045
CH	−0.121	0.120	−0.019	0.026
CZ	0.023	0.040	0.061	−0.102
DE	0.013	0.010	0.108	−0.098
EE	−0.091	0.026	−0.004	0.055
ES	0.020	0.056	0.079	−0.140

Table 11: (continued)

Country	V_SE	V_ST	V_OC	V_CO
FI	−0.020	0.065	0.059	−0.061
FR	−0.010	0.055	0.065	−0.091
GB	0.049	0.010	0.100	−0.131
HR	0.015	−0.061	−0.097	0.112
HU	−0.026	−0.058	0.057	0.028
IE	−0.010	−0.016	0.047	−0.033
IT	0.055	0.028	0.052	−0.126
LT	−0.082	0.079	0.003	0.026
LV	−0.121	0.006	−0.051	0.141
ME	−0.096	0.090	0.003	0.025
NL	−0.010	0.031	0.063	−0.061
NO	0.044	0.071	0.041	−0.115
PL	0.006	0.025	−0.056	0.030
PT	0.011	−0.036	0.098	−0.063
RS	−0.018	−0.042	−0.004	0.040
SE	0.042	−0.045	0.078	−0.055
SI	−0.057	−0.025	0.053	0.012
SK	−0.010	−0.006	−0.009	−0.007
avg.	−0.018	0.019	0.028	−0.022
sd	0.052	0.048	0.055	0.075

V_SE – Self-Enhancement, V_ST – Self-Transcendence, V_OC – Openness to Change, V_CO – Conservation.

Table 12: The impact of higher order values on the level of education.

Higher order value	Est. param. (1)	p Value (1)	Est. param. (2)	p Value (2)
Self-Enhancement	0.109	<0.001	0.103	<0.001
Self-Transcendence	0.165	<0.001	0.167	<0.001
Openness to Change	0.198	<0.001	0.198	<0.001
Conservation	−0.380	<0.001	−0.385	<0.001

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