*Paper accepted for presentation at Artificial Economics 2009, Valladolid, 10-11 Sept. 2009*

# Simulation of Effects of Culture on Trade Partner Selection

Gert Jan Hofstede, Catholijn M. Jonker, and Tim Verwaart

**Abstract** The criteria that traders use to select their trade partners differ across cultures. The rational criterion of expected profit of the next contract to be negotiated dominates the decision in individualistic, egalitarian, uncertainty tolerant cultures. In other cultures, criteria like personal relations, group membership, status difference and trust may strongly influence trade partner selection. There also exist differences in the level of information about potential partners that traders require before entering into business contacts. This paper models the role of culture at the level of individual agents, based on Hofstede's five dimensions of culture. The model is applied in multi-agent simulations, that are designed as a research tool for supply chain research. The model is implemented as a random selection process, where potential partners have unequal probabilities of being selected. The factors influencing the probabilities are: expected profit and trust (learnt from previous contacts with potential partners or reputation), common group membership, societal status, and personal relations. Results are presented, that indicate that Hofstede's model can be used to simulate the effect of culture on the formation and maintenance of business relationships.

G.J. Hofstede
Wageningen University, Hollandseweg 1, 6706 KN Wageningen, The Netherlands, e-mail: gertjan.hofstede@wur.nl

C.M. Jonker
Delft University of Technology, Mekelweg 4, 2628 CD Delft, The Netherlands, e-mail: c.m.jonker@tudelft.nl

T. Verwaart
LEI Wageningen UR, Postbus 29703, 2502 LS Den Haag, The Netherlands, e-mail: tim.verwaart@wur.nl

# 1 Introduction

Strategies for selecting trade partners are known to be heterogeneous among traders operating in the same environment. For instance, Kirman (2008) describes trade on the Marseille wholesale fish market: according to recorded transaction data of this market, some buyers are loyal to sellers, while others persistently display shopping behaviour, moving from seller to seller. Weisbuch et al. (2000) showed how this heterogeneous behaviour can be reproduced in a multi-agent simulation. The approach is based on reinforcement learning of expected profitability of trade relations, where the length of an agent's memory and its sensitivity to past experience are parameters that differentiate agent behaviour. An interesting observation in that research is, that both loyal buyers and shopping buyers survive in this market.

Literature on international business, e.g. Hofstede and Hofstede (2005), Trompenaars and Hampden-Turner (1993) suggests that the distribution of the parameters introduced by Weisbuch et al. (2000) - i.e. the length of memory and loyalty to business relations versus the drive to explore new opportunities – will be different across different cultures. Furthermore, besides expected profit, phenomena like trust and personal relations are relevant and are known to have different influence on trade partner selection and network formation across cultures (G.J. Hofstede, 2007). In some societies, economic systems may be based on trust, in other societies on opportunism. Gorobets and Nooteboom (2006) showed by means of a multi-agent simulations that both types of systems might be viable in different societies. However, in intercultural trade these differences may hamper trade relations, because trust and opportunism may be appreciated differently. Also, loyalty may be appreciated differently across cultures.

The relation between culture and international trade has been studied at the macro level, e.g. (Guo, 2004; Kónya, 2006). The research reported in the present paper models the relation between culture and trade partner selection at the micro level. The purpose is the development of multi-agent simulations that can be used as an instrument in supply network research, in combination with human gaming simulations (Jonker et al., 2006; Meijer et al., 2006). The simulations and the human games are based on the paradigm of transaction cost economics (Williamson, 1985, 1998), with focus on asymmetric information, opportunism and trust. The main processes to be modeled in the agents are trade partner selection and bargaining in the pre-contract phase, and the decisions to either cooperate or defect and either trust or monitor and enforce in the post-contract phase of transactions. The present paper focuses on the process of trade partner selection.

The computational models of the effects of culture are based on the work of G. Hofstede (2001). Hofstede identified five dimensions of national cultures, that can be measured by a numerical index. The dimensions are: individualism versus collectivism, inequality of power, uncertainty avoidance, masculinity versus femininity, and long-term versus short-term orientation. G.J. Hofstede et al. (2006, 2008a, 2008b, 2008c, 2009) describe production rule models of the influence of culture on trade processes for each of the individual dimensions. Section 2 of the present

paper summarises the analyses reported in these models in as far as they are relevant for trade partner selection.

Although other dimensional models of culture could certainly be used for similar purposes, Hofstede's framework was chosen over possible other candidates (such as Hall, 1976; House et al., 2004; Schwartz, 1994; Trompenaars and Hampden-Turner, 1993) for various reasons. First, Hofstede's work is parsimonious and accessible, with only five dimensions compared to GLOBE's 18, and with its 1-to-100 scales. Second, it has a wide scope, compared to Trompenaars and Hampden-Turner, whose dimensions are statistically intercorrelated and can be described as aspects of only individualism and power distance (Smith et al., 1996) or Hall who focused on the dimension of individualism (low-context communication) versus collectivism (high-context communication). Those models miss out on issues related to gender roles, anxiety and Confucian values. Third, it has the greatest empirical base of these studies, with a well-matched sample of 117.000 respondents to the original study plus hundreds of replications during a quarter century that validate the model (Kirkman et al., 2006; Schimmack et al., 2005). Fourth, it is the most widely used. It has survived fashions and hasty storms of criticism (Smith, 2006; Sóndergaard , 1994). Fifth and most important, it shows continued predictive value for many societal phenomena (Hofstede, 2001; Smith, 2002). The most likely candidates for extension of the Hofstede model are the new dimensions found by Minkov using World Value Survey data (Minkov, 2007).

This paper aims to integrate the rules for the individual Hofstede dimensions into a model of the partner selection process, simultaneously taking all five dimensions into account. The basis of the model is the reinforcement learning model proposed by Weisbuch et al. (2000), enhanced with "non-rational" aspects that are relevant from the culture perspective. Section 3 describes the model.

The main goal of the authors' current research is to assess the feasibility of the Hofstede dimensions for agent-based simulation of the effects of culture on international trade, in particular in international supply chains of food products, where intensive trade among many small-scale firms occurs, and where usually product quality information is asymmetric. Section 4 presents results of simulations that indicate that believable simulation results can be obtained by applying the Hofstede model. Section 5 concludes the paper.

## 2 Hofstede's Dimensions and Trade Partner Selection

Behaving as a good, upstanding member of the group is at the core of the lives of all beings that live in social groups (Wilson, 2007). Human beings are intensely social and spend up to twenty years being taught how to act as virtuous members of society. But how to be virtuous? Different societies have found different answers to that question. In some, rationality is a prominent virtue; in others, common sense. In some, virtue consists primarily in honouring tradition; in others, it consists more of becoming prosperous. Although traders basically attempt to maximize profits, their cultural background sets limits to the means they use, to

the partners they deal with, to the extent they get personally involved with partners, to loyalty, to the time spent on establishing relations, to bargaining tactics, to duration of bargaining etc. (Hofstede and Hofstede, 2005; Trompenaars and Hampden-Turner, 1993).

In a series of papers, G.J. Hofstede et al. (2006, 2008a, 2008b, 2008c, 2009) proposed a process model of trading agents, inspired by the context of the trust and tracing game and transaction cost economics, and described the effects of culture on the processes for each of the individual five dimensions of culture as identified by G. Hofstede (2001). The relevant processes are:

- Trade goal selection: sell or buy, what product, quality level;
- Partner selection: search for a partner to deal with, agree to start negotiation;
- Negotiation: bargain about conditions and guarantees, resulting in a contract;
- Delivery: deliver according to the contract or use opportunities to defect;
- Monitoring and enforcing: spend resources on tracing or trust the partner;
- Belief update: while dealing, record experience to apply it in the future.

The present paper focuses on partner selection. The next paragraphs summarize the effects of culture on trade partner selection for each dimension.

*Individualism versus collectivism.* In individualistic societies people primarily feel to be an individual, responsible for his or her personal actions and well-being. Traders in individualistic societies traders actively build and maintain relations, and cut-off in case of insufficient utility. In collectivistic societies people have given group memberships and relations, that cannot be cut-off, and feel responsible for and loyal to their ingroup. Traders prefer ingroup partners, but outgroup partners can get ingroup status by mutual investment in the relation.

*Power distance.* This dimension differentiates between hierarchical societies where the less powerful accept that power is distributed unequally, and egalitarian ones where power relations are functional, as in principal-agent relations. In hierarchical societies, traders prefer business partners with equal status. They avoid the more powerful, but cannot refuse business proposed by a more powerful.

*Uncertainty avoidance.* In extremely uncertainty avoiding societies, people fear what they are unfamiliar with (xenophobia) and feel uncomfortable in uncertain situations. Uncertainty avoiding traders are distrusting and do not deal with strangers and people belonging to different social classes. Traders from uncertainty-tolerant societies may actively search for new partners without limits.

*Masculinity versus femininity.* In masculine societies people are oriented toward competition, performance, and material success. Traders actively search for new partners, or better: opponents, and experience trade as a game to be won. In feminine societies, people are oriented toward cooperation and take care for others. They prefer relations with a good atmosphere, prefer getting acquainted before doing business, forgive betrayal but avoid repetitive cheaters.

*Long-term versus short-term orientation.* In long-term oriented societies, thrift and perseverance are respected as virtues. Traders actively build and maintain network relations and see them as an asset for future prosperity. In short-term oriented societies consumption, social obligations, and face are important, for instance showing off by doing business with a high status partner.

## 3 Representation in Agents

Data for the trade partner selection process is modeled into the agents as follows:
- the agent's culture <IDV*, PDI*, UAI*, MAS*, LTO*>: five variables that represent the Hofstede indices, scaled to the interval [0, 1];
- parameters $\beta$ and $\gamma$ that represent an agent's loyalty ($\beta$) and learning characteristic ($\gamma$), according to the model of Weisbuch et al. (2000);
- a *partner model* (a set of variables) for each potential partner;
- *labels* that represent an agents group memberships and societal status.

An agent's labels are visible to other agents; the other information is private.

A *partner model* for partner *j* represents an agent's beliefs about *j*:
- the expected utility $J'_j$, learnt in previous business contacts, as a basis for preference in partner selection;
- experience-based trust $t_j$: a subjective probability that the partner will cooperate once a contract has been closed, also representing the experienced quality of the relation;
- group distance $D_j$, between partner and self, computed from *group labels*;
- belief about the partners societal status $s_j$, and the status difference $S_j=s_j-s_i$ with self, observed from *status labels*.

Note that the agents are not modeled to be aware of other agents' cultures.

The mechanism for partner selection is based on the reinforcement learning of expected utility proposed by Weisbuch et al. (2000). Agents select their partners at random, with probability:

$$P_j = \exp(\beta J_j) / \sum_{j'} \exp(\beta J_{j'}) , \quad (1)$$

where $\beta$ is a parameter that represents an agent's loyalty to partners with high values of $J_j$ ; $J_j$ represents the preference for a particular partner, based on experience of profitability of previous deals with that partner, and effected by the agent's culture. The effects of culture on partner preference are summarized in Table 1.

**Table 1.** Partner model information taken into account for computing preference

| Culture type | Trust / relation | Distrust | Ingroup | Out-group | Status difference | Partner status |
|---|---|---|---|---|---|---|
| Individualist | + | | | | | |
| Collectivist | | | + | | | |
| Hierarchical | | | | | - | |
| Egalitarian | | | | | | |
| Unc.avoiding | | - | | - | - | |
| Unc.tolerant | | | | | | |
| Masculine | | | | | | |
| Feminine | + | | | | | |
| LT-oriented | + | | | | | |
| ST-oriented | | | | | | + |

+ indicates that the partner trait increases preference in the particular type of culture;
- indicates that the trait has a negative influence on preference.

Table 1 presents 5 factors that increase the preference for another agent, depending on culture. In individualistic, feminine, or long-term oriented cultures the quality of the trusted relation with the partner is more important than in other cultures. In collectivistic cultures ingroup partners are more probable to be selected than outgroup partners. In short-term oriented cultures, there is a special preference for partners with a high societal status. The increasing effect of culture on preference for $J_j$ is computed as follows:

$$e^+_j = \max\{\text{IDV}^* t_j, (1\text{-MAS}^*)t_j, \text{LTO}^* t_j, (1\text{-IDV}^*)(1\text{-}D_j), (1\text{-LTO}^*)s_j\} , \quad (2)$$

so influence of a single factor is modeled as the product of the normalized Hofstede index and the value of the relevant belief in the partner model, all represented on the interval [0, 1], and from these the maximal value is selected.

The decreasing effect is computed similarly:

$$e^-_j = \max\{\text{UAI}^*(1\text{-}t_j), \text{UAI}^* D_j, \text{PDI}^*|S_j|, \text{UAI}^*|S_j|\} . \quad (3)$$

The total effect of culture

$$e_j = e^+_j - e^-_j \quad (4)$$

is used to compute the agent's preference for partner $j$, taking the history of previous dealing $J'_j$ and culture into account:

$$J_j = (1 + e_j)^\alpha J'_j \quad (5)$$

Where the parameter $\alpha$ determines the extent of the cultural impact on preference.

The resulting preference $J_j$ is used in equation (1) to compute the probability that $j$ will be selected. Parameter $\beta$ in equation (1), representing loyalty, also depends on an agent's culture. We expect it to be increased to a maximal value in long-term oriented societies, and to be decreased to a minimal value in uncertainty-tolerant or masculine societies.

$$b = \max\{\text{LTO}^*\} - \max\{1\text{-UAI}^*, \text{MAS}^*\} . \quad (6)$$

$$B = \beta' + (\beta^{\max}\text{-}\beta')(|b|+b)/2 - (\beta'\text{-}\beta^{\min})(|b|-b)/2 , \quad (7)$$

where $\beta'$ represents a parameter that is assigned to the agent at initialization, with $0 < \beta^{\min} < \beta' < \beta^{\max}$ .

The experience of dealing with agent $j$ is processed after each negotiation:

$$J'_j(n) = (1 - \gamma)J'_j(n - 1) + \gamma u_j(n) , \quad (8)$$

where $u_j(n)$ is the utility of the $n$-th negotiation result with $j$; $u_j(n) = 0$ if the negotiation was terminated without agreement. The value of $\gamma$ is expected to depend on culture: an higher value in feminine, a lower value in uncertainty avoiding cultures:

$$c = 1 - \text{MAS}^* - \text{UAI}^* \quad (9)$$

$$\gamma = \gamma' + (\gamma^{\max}\text{-}\gamma')(|c|+c)/2 - (\gamma'\text{-}\gamma^{\min})(|c|-c)/2 \quad (10)$$

Parameter $\gamma$' is assigned to the agent at initialization, with $0 < \gamma^{min} < \gamma' < \gamma^{max} < 1$ .

After a agent has targeted a partner, applying equation (1), it sends a proposal to negotiate about a deal. The receiver may either accept or ignore the proposal. The proposing agents waits for some time, and if it receives no reply, it updates $J'_j$ with $u_j$=0 , see equation (1), and than tries and targets a partner again.

If an agent has no negotiation going on, it checks for received proposals. It may have recent proposals from several agents simultaneously. From the simultaneous proposers, it selects the one with the maximum preference. There is one additional effect: agents from hierarchical societies that face a higher-ranked proposer are inclined to accept even if they do not prefer the partner, because it is not done to refuse in that case. The acceptability is calculated for all proposers:

$$a_j = J'_j / \max_{j'}(J'_{j'}) + (1-J'_j)\mathrm{PDI}^{*}\max(S_j, 0) . \quad (11)$$

Subsequently the agent selects, from the agents that proposed to negotiate, an agent $k$ with maximal acceptability and decides whether to accept its proposal or to start looking for a partner by itself, with probabilities:

$$p(\text{start negotiation with } k) = a_k ; \quad (12)$$

$$p(\text{start new partner selection}) = 1 - a_k . \quad (13)$$

## 4 Simulation Results

This section presents two series of simulation results. In the first series, the effects of the individual Hofstede dimensions are investigated by varying the index of one dimension, while keeping the other indices constant. These simulations are run in culturally homogeneous societies, i.e. all agents having equal cultural settings and, in some simulations, different group memberships or different societal status. The purpose of this first series of experiments is to verify the implementation of the model. In the second series, Hofstede's indices for some imaginary countries are used to simulate trade patterns emerging in multicultural settings. The results show that believably differentiated patterns can be generated. However, the model needs further tuning and validation with real-word data in order to generate realistic results for real countries.

Tables 2 presents results of simulation runs in different cultural settings. The simulation model is based on Meijer et al. (2006). In the simulation, agents can select partners, negotiate, deliver, and process the experience gained in these activities, to update belief about expected utility $J'_j$ and trust or quality of the relationship $t_j$ . The agents are homogeneous: all agents have equal parameter settings. In all runs, eight supplier agents and eight customer agents were trading, all with parameters $\alpha = 1$ , $\beta' = 1.5$ , $\beta^{min} = 0.3$ , $\beta^{max} = 3$ , $\gamma' = 0.3$ , $\gamma^{min} = 0.1$ , $\gamma^{max} = 0.5$ . The normalized indices of culture were all set to 0.5 , except one, which was set to either 0.1 or 0.9. The agents had no group distance or status difference.

**Table 2.** Loyalty, expressed as percentage of trade contacts with the most frequently contacted partner in different (artificial) cultural settings; $\alpha = 1$ , $\beta' = 1.5$ , $\beta^{min} = 0.3$ , $\beta^{max} = 3$ , $\gamma' = 0.3$ , $\gamma^{min} = 0.1$ , $\gamma^{max} = 0.5$; all agents have status 0.5 and common group labels

| Value of index | PDI* | UAI* | IDV* | MAS* | LTO* |
|---|---|---|---|---|---|
| 0.9 | 28 | 21 | 28 | 26 | 45 |
| 0.1 | 31 | 32 | 30 | 35 | 24 |

PDI* = 0.9 : hierarchical; PDI* = 0.1 : egalitarian;
UAI* = 0.9 : uncertainty avoiding; UAI* = 0.1 : uncertainty tolerant;
IDV* = 0.9 : individualistic; IDV* = 0.1 : collectivistic;
MAS* = 0.9 : masculine; MAS* = 0.1 : feminine;
LTO* = 0.9 : long-term oriented; LTO* = 0.1 : short-term oriented.

**Table 3.** Loyalty, with increased $\beta' = 3$ , $\beta^{max} = 10$ (other setting as in Table 2)

| Value of index | PDI* | UAI* | IDV* | MAS* | LTO* |
|---|---|---|---|---|---|
| 0.9 | 38 | 21 | 33 | 34 | 71 |
| 0.1 | 40 | 36 | 51 | 44 | 29 |

As may be expected from equation (6), Table 2 shows that long-term orientation, uncertainty avoidance and masculinity effect the emerging loyalty. As Table 3 shows, increasing the basic values of $\beta'$ and $\beta^{max}$ increases average loyalty, but the cultural effect remains. In particular, the increasing effect of LTO* is very strong with the high value of $\beta^{max}$, because of the non-linearity of equation (1). A similar effect occurs with low IDV* in this setting. Because of increased preference for ingroup partners, together with increased $\beta$ and the non-linearity of equation (1), the agents stick to partners they selected in the beginning of the simulation. Further experiments are run with $\beta' = 1.5$ , $\beta^{min} = 0.3$ , $\beta^{max} = 3$ .

In similar experiments, it was found that reducing $\gamma'$ to 0.1 reduced the learning of loyalty so that no differentiation was found; increasing it to 0.5 did not produce results significantly different from Table 2. In all further experiments $\gamma' = 0.3$ .

Table 4 presents results with heterogeneous agents with respect to group distance, in homogeneous cultures. The results indicate that in uncertainty avoiding, collectivistic, and, surprisingly, long-term oriented societies ingroup partners are preferred; in uncertainty avoiding societies due to aversion against anything unfamiliar; in collectivistic societies due to ingroup preference. In the LTO society, loyalty makes agents stick to ingroup partners they selected in the beginning (when individual preferences are equal) because IND* = UAI* = 0.5.

Table 5 displays the effects of culture on trade situations with unequal societal status. Trade with partners from different classes is not done in hierarchical societies. In uncertainty avoiding societies, the aversion against what is different reduces cross-class shopping. In the simulations with masculine agents, the agents are less loyal, have no threshold toward contacting lower classed agents, and the powerful agents rapidly learn exploit their power, resulting in increased cross-class shopping.

**Table 4.** Outgroup shopping, expressed as percentage of trade contacts with outgroup partners; settings as in table 1, except group distance: both suppliers and customers are divided into equally sized groups 1 and 2 with group distance $D_j = 1$

| Value of index | PDI* | UAI* | IDV* | MAS* | LTO* |
|---|---|---|---|---|---|
| 0.9 | 31 | 20 | 35 | 28 | 16 |
| 0.1 | 27 | 41 | 18 | 30 | 42 |

**Table 5.** Cross-class shopping, expressed as percentage of trade contacts with partners having a different status; settings as in table 1, except status: half of suppliers and half of customers have status 0.01 , the others have status 0.99 ; group distance $D_j = 0$

| Value of index | PDI* | UAI* | IDV* | MAS* | LTO* |
|---|---|---|---|---|---|
| 0.9 | 24 | 27 | 34 | 40 | 35 |
| 0.1 | 36 | 35 | 36 | 31 | 34 |

The results presented so far concern artificial cultures. Table 6 presents results obtained with cultural settings that are similar to actual average Hofstede indices of national cultures. The results illustrate that differentiated behavior emerges with differentiated loyalty and different inclination to outgroup shopping. Results for China show a weak inclination to outgroup shopping. This may seam contradictory with China's position on the world market. In Chinese culture ingroup trading is preferred, but after getting acquainted and mutual investment in the personal relation, an outgroup partner may become accepted as ingroup. Once the relational barriers are broken, uncertainty avoidance and masculinity come to effect.

The results for outgroup shopping of Sweden and USA are similar, in spite of the different cultures. In experiments eight customer agents with USA-like configuration and eight customer agents with Swedish-like configuration traded with eight Chinese-like supplier agents. Different patterns of customer loyalty emerged, as displayed in Tables 7 and 8. The tables display the number of successful transactions between each supplier and each buyer. In the simulation with USA-like agents, the number of empty cells is 24 on 203 transactions, and average customer loyalty equals 46 percent. In the simulation with Swedish-like agents, the number of empty cells is 31 on 293, and average customer loyalty equals 56 percent.

**Table 6.** Average loyalty and inclination to outgroup shopping in societies of agents with two groups, with group distance $D_j = 1$, no status difference, other parameters as in Table 1; the cultures are modeled with some similarity to actual national cultures

| Culture similar to | PDI* | UAI* | IDV* | MAS* | LTO* | loyalty | outgroup shopping |
|---|---|---|---|---|---|---|---|
| China | 0.7 | 0.3 | 0.1 | 0.7 | 0.9 | 68 | 8 |
| India | 0.7 | 0.5 | 0.5 | 0.5 | 0.7 | 38 | 22 |
| Russia | 0.9 | 0.9 | 0.3 | 0.3 | 0.3 | 36 | 15 |
| Sweden | 0.3 | 0.3 | 0.7 | 0.1 | 0.3 | 32 | 44 |
| USA | 0.5 | 0.5 | 0.9 | 0.7 | 0.3 | 23 | 42 |

**Table 7.** Number of successful transaction between 8 USA-like customer agents and 8 Chinese-like supplier agents, in 500 time steps.

| Agent | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
|---|---|---|---|---|---|---|---|---|
| C1 | 2 | 1 | 1 | 9 | 5 | | 8 | |
| C2 | 1 | 1 | 5 | | 5 | 1 | 1 | 25 |
| C3 | | | 15 | | | | | 1 |
| C4 | | 6 | | | 10 | 6 | 6 | 4 |
| C5 | | 3 | | 5 | | 7 | 3 | 2 |
| C6 | 1 | 6 | | 3 | 5 | | 3 | |
| C7 | 6 | 4 | 5 | 11 | 1 | | | |
| C8 | 10 | 1 | | 3 | | 1 | 10 | |

**Table 8.** Number of successful transaction between 8 Swedish-like customer agents and 8 Chinese-like supplier agents, in 500 time steps.

| Agent | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
|---|---|---|---|---|---|---|---|---|
| C1 | | 1 | 3 | | 6 | 30 | | |
| C2 | | 1 | 17 | 9 | | | 2 | 6 |
| C3 | 4 | 20 | | | | 1 | 2 | |
| C4 | 2 | 11 | | 4 | | | 22 | |
| C5 | 2 | | 18 | | | 13 | | |
| C6 | 30 | | | 2 | 1 | | 8 | |
| C7 | 1 | | 11 | 3 | 15 | | | 10 |
| C8 | 7 | | | | 8 | | 11 | 12 |

## 5 Conclusion

The contribution of this work is that it shows how a model of culture can be formulated to simulate culturally differentiated behavior of agents. The model of Hofstede (2001) has been applied to partner selection in international trade in a context where personal relations between traders are important. The partner selection is based on the model of Weisbuch et al. (2000). Culture is modeled to effect preference for particular partners and parameters of the partner selection mechanism (the loyalty parameter and the learning parameter).

The model is implemented in agents. Multi-agent simulations have been run to verify the correct implementation of the model and to produce example results. Although further refinements are possible, the results show that believable behaviors emerge. The results qualitatively represent effects expected on the basis of Hofstede's theory. However, validation against empirical data in the situations that the model aims to describe, is required to calibrate parameters to actual trader's behavior and to scale Hofstede's indices to the simulation indices.

The situation that is modeled is a common market place. All agents can be aware of all other agents. The model does not include network extensions: the population of agents is fixed. The agents are free to select any partner, and the partner is free to enter into negotiations or to ignore proposals. The agents have

labels that indicate their group memberships and societal status. Labels are visible to all agents and can be used for partner selection. The information about transactions is private. It is only available to the transaction partners. They can use it for future partner selection. An important characteristic of the present model is that agents do not have a theory of culture. They act according to their cultural programming, but they are not aware of cultural difference with partners.

The purpose of this model of partner selection is to simulate the behavior of players in trade games (Jonker et al., 2006; Meijer et al., 2006). In order to validate the model for this purpose, it has to be integrated with models of bargaining and contract fulfillment. The combined models can be tuned to results obtained in human gaming simulations, and their usefulness for supply chain research can be assessed. Those tasks remain for future research.

## References


A. Gorobets A, B. Nooteboom. In C. Bruun, editor, *Advances in Artificial Economics*, Lecture Notes in Economics and Mathematical Systems 584: 121-132. Springer, Berlin, 2006.

R. Guo. How culture influences foreign trade: evidence from the U.S. and China. *Journal of Socio-Economics* 33: 785-812, 2004.

E.T. Hall. *Beyond culture*. Anchor, Garden City NY, 1976.

G. Hofstede. *Culture's Consequences, 2nd Edition*. Sage, Thousand Oaks CA, 2001.

G. Hofstede, G.J. Hofstede. *Cultures and Organizations: Software of the Mind. Third Millennium Edition*. McGraw-Hill, New York, 2005.

G.J. Hofstede. Trust and Transparency in Supply Netchains: a Contradiction? In W.Y.C. Wang et al., editor, *Supply Chain Management: Issues in the New Era of Collaboration and Competition*. Idea Group, Hershey PA: 2007.

G.J. Hofstede, C.M. Jonker, S. Meijer, T. Verwaart. Modelling Trade and Trust across Cultures. In K. Stølen, W.H. Winsborough, F. Martinelli, F. Massacci, editors, *Trust Management: 4th International Conference, iTrust 2006, Proceedings*, LNCS 3968: 120-134. Springer, Berlin, 2006.

G.J. Hofstede, C.M. Jonker, T. Verwaart. Modeling Culture in Trade: Uncertainty Avoidance. *2008 Agent-Directed Simulation Symposium (ADSS 2008), Spring Simulation Multiconference 2008*: 143-150. SCS, San Diego, 2008a.

G.J. Hofstede, C.M. Jonker, T. Verwaart. Individualism and Collectivism in Trade Agents. In N.T. Nguyen, L. Borzemski, A. Grzech, M. Ali, editors, *New Frontiers in Applied Artificial Intelligence, Proceedings of IEA/AIE 2008*, LNAI 5027: 492-501. Springer, Berlin, 2008b.

G.J. Hofstede, C.M. Jonker, T. Verwaart. Long-term Orientation in Trade. In K. Schredelseker, F. Hauser, editors, *Complexity and Artificial Markets*, Lecture Notes in Economics and Mathematical Systems 614: 107-119. Springer, Berlin, 2008c.

G.J. Hofstede, C.M. Jonker, T. Verwaart. Modelling Power Distance in Trade. In N. David, J.S. Sichman, editors. *Multi-Agent-based Simulation IX, MABS 2008, Revised Selected Papers*, LNAI 5269: 1-16. Springer, Berlin, 2009.

R.J. House, P.J. Hanges, M. Javidan, P.W. Dorfman, V. Gupta. *Leadership culture and organizations: The GLOBE study of 62 societies*. Sage, Thousand Oaks CA, 2004.

C.M. Jonker, S. Meijer, D. Tykhonov, T. Verwaart. Multi-agent Model of Trust in a Human Game. In P. Mathieu, B. Beaufils, O. Brandouy, editors, *Artificial Economics*. Lecture Notes in Economics and Mathematical Systems 564: 91-102. Springer, Berlin, 2006.

B.R. Kirkman, K.B. Lowe, C.B. Gibson. A quarter century of Culture's Consequences: a review of empirical research incorporating Hofstede's cultural values framework. *Journal of International Business Studies, 37*: 285-320, 2006.

A. Kirman. Artificial Markets: Rationality and Organisation. In K. Schredelseker, F. Hauser, editors, *Complexity and Artificial Markets*, Lecture Notes in Economics and Mathematical Systems 614: 195-234. Springer, Berlin, 2008.

I. Kónya. Modeling Cultural Barriers in International Trade. *Review of International Economics* 14: 494-507, 2006.

S. Meijer, G.J. Hofstede, G. Beers, S.W.F. Omta. Trust and Tracing game: learning about transactions and embeddedness in a trade network. *Production Planning and Control* 17: 569-583, 2006.

M. Minkov. *What makes us different and similar, A new interpretation of the World Values Survey and other cross-cultural data*. Klasika i Stil, Sofia, 2007.

U. Schimmack, S. Oishi, E. Diener. Individualism: A Valid and Important Dimension of Cultural Differences Between Nations. *Personality and Social Psychology Review*, 9(1), 17-31, 2005.

S.H. Schwartz. Beyond individualism / collectivism: new dimensions of values. In U. Kim, H.C. Triandis, C. Kagitçibasi, S.C. Choi, G. Yoon, editors. *Individualism and collectivism: theory, application and methods*, 85-119. Sage, Thousand Oaks CA, 1994.

P.B. Smith. Culture's consequences: Something old and something new. *Human Relations* 55(1): 119-135, 2002.

P.B. Smith. When elephants fight, the grass gets trampled: the GLOBE and Hofstede projects. *Journal of International Business Studies* 37: 915-921, 2006.

P.B. Smith, S. Dugan, F. Trompenaars. National culture and the values of organizational employees: A dimensional analysis across 43 nations. *Journal of Cross-Cultural Psychology* 27: 231-264, 1996.

M. Sóndergaard. Hofstede's consequences: a study of reviews, citations and replications. *Organization Studies* 15, 447-456, 1994.

F. Trompenaars, C. Hampden-Turner. *Riding the waves of culture: understanding cultural diversity in business, 2nd edition*. Economist Books, London, 1993.

G. Weisbuch, A. Kirman, D. Herreiner. Market Organisation and Trading Relationships. *Economic Journal* 110: 411-436, 2000.

O.E. Williamson. *The Economic Institutions of Capitalism*. Free Press, New York, 1985.

O.E. Williamson. Transaction Cost Economics: how it works, where it is headed. *De Economist* 146: 23-58, 1998.

D.S. Wilson. *Evolution for Everyone*. Delacorte Press, New York, 2007.