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Modeling Power Distance in Trade

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Abstract. Agent-based computational economics studies the nature of economic processes by means of artificial agents that simulate human behavior. Human behavior is known to be scripted by cultural background. The processes of trade partner selection and negotiation work out differently in different communities. Different communities have different norms regarding trust and opportunism. These differences are relevant for processes studied in economics, especially for international trade. This paper takes Hofstede's model of national culture as a point of departure. It models the effects on trade processes of one of the five dimensions: power distance. It formulates rules for the behavior of artificial trading agents and presents a preliminary verification of the rules in a multi-agent simulation.

Keywords: culture, negotiation, trust, deceit, simulation.

1 Introduction

Any experienced international traveler knows that economic transactions do not come to pass in the same way across cultures. Haggling, checking on quality, and style of negotiation vary considerably across the world.

In the quest to understand the mechanisms that underlie these differences this article adopts the approach of designing agent-based simulation models. It builds on [1], that describes the modeling of behavioral differences of participants in a human gaming simulation. The game gives players the choice to either trust their trade partners to live up to their promises, or to spend money, time, and relational assets to check (trace) them. In the game, differences are observed between players from different cultural backgrounds [2]. Generally negotiation - which is an essential process in trade - is recognized to develop differently in different cultural settings, see e.g. [3]. For electronically mediated negotiations, [4] reports considerable differences across countries with respect to expectations and process.

Negotiation relates to the pre-contract phase of economic transactions. Trust and opportunism predominantly relate to the post-contract phase: the delivery. [5] gives evidence that both trust and opportunism can be profitable in this phase. It suggests

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that in different societies self-sustaining systems of either trust or opportunism might prevail. [6] supports these findings: the extent to which people expect deceit and are likely to lie in business negotiations differs considerably across cultures.

The discipline of agent-based economics [7] recognizes that using artificial agents to simulate human behavior contributes to the understanding of economic processes. Models of cultural influences on behavior in searching, bargaining, monitoring, and enforcing contracts are essential for developing realistic agents that can help us understand the differentiation of economic systems and institutions across the world. The design of culturally scripted agents serves several purposes. First it is useful for research into the effects of culture in trade, as described in the previous paragraph. Secondly, it can be used in education and training to make traders aware of cultural differences. Furthermore, the models can be used for developing negotiation support systems.

The approach taken by the authors is to make use of the widely used 5-dimension framework of Hofstede [8]. The present paper's research goal is to investigate the role of the cultural dimension of power distance as a determinant of trade processes and outcomes. We adopt the perspective of the trader that uses the endemic logic of a particular orientation on the power distance scale.

2 Power Distance and Trade

Can traders predict the behavior of potential partners depending on which part of the world these partners come from? Granting that each individual is unique, they can. For this, traders need knowledge about the socialization that the potential partners underwent in childhood, in other words about their culture. In many cases, nationality is a good predictor of the participants' basic values. For instance, business in China tends to be done over a meal, and observing social hierarchy during meals is important. In the Netherlands, business is done during working hours and little concern is given to the formal status of traders. This statement is inadequate for some Chinese and some Dutch traders but it is certainly more true than its opposite would be. The work of Hofstede [8, 9] characterizes these values in the form of five basic dimensions of social life that pertain to identity, power distance, gender roles, fear of the unknown, and long- vs short-term orientation.

The dimension of power distance is central in the present paper. Hofstede [8] defines power distance as the extent to which the less powerful accept and expect that power is distributed unequally. The dimension runs from egalitarian (*small power distance, e.g., in* Anglo, Germanic and Nordic cultures) to hierarchical (*large power distance,* in most other cultures; see table 1).

Table 1. Some distinctions between norms in hierarchical and egalitarian societies

Large power distance (hierarchical)	Small power distance (egalitarian)
Might is right	No privileges and status symbols
Formal speech; acknowledgement	Talk freely in any context
Dictate, obey	Negotiate
Show favor to mighty business partners	Treat all business partners equally

There are some pairs of countries in the Hofstede database that differ on power distance more than they do on other dimensions. They are Russia - Israel, Costa Rica - Guatemala, and France - Austria. Still it would not do to take subjects from these pairs of countries, have them negotiate, and attribute the results to difference in power distance. Besides cultural differences on other dimensions, differences in perceived identity, historical antecedents, personality factors and a host of other context factors have to be taken into account. By using software agents, these other contextual factors can be excluded and power distance can be isolated. However, simulation results will have to be interpreted as an abstraction that cannot be extrapolated to the real world without much caution. Isolating one dimension for the sake of experiment is a decidedly artificial method. In real life, the dimensions always operate as one whole, a cultural Gestalt, together with contextual factors. One of the contextual factors is personality: in any trade situation it matters what personalities the partners bring to the table. As it turns out personality and culture are not independent. In a meta-analysis of their mutual cross-country data Hofstede and McCrae [10] found that power distance correlates negatively with extraversion and openness to ideas and positively with conscientiousness.

In spite of the limitations of isolating a single dimension, we argue that the experiment is worthwhile carrying out. Empiric evidence for the relevance of the power distance dimension for negotiation processes is given in [3]. Furthermore, modeling the isolated dimensions can serve as a preparation for the more complicated integral modeling of culture's consequences for trade.

The core of trade is the execution of transactions: exchanging commodities or rights for money. Transactions are based on a contract that may specify additional conditions that enforce the delivery according to the contract. The contract is to be negotiated among the trade partners. Contracting is not the only relevant activity of trading agents, however. Fig. 1 presents an overview of relevant processes.

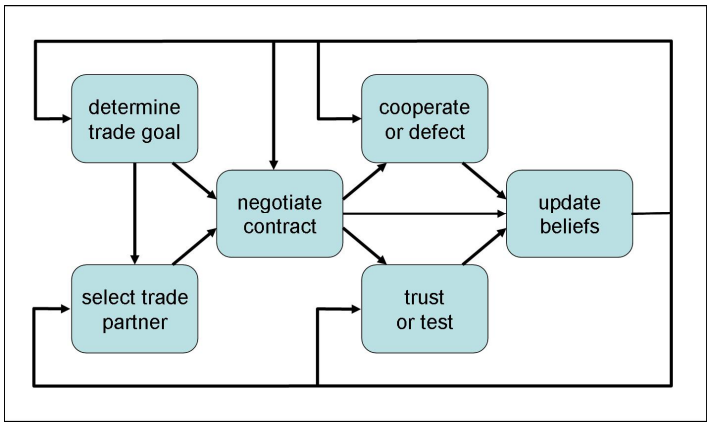

Fig. 1. Processes and internal information flow of a trading agent

Before entering negotiations, agents have to select each other as partners to negotiate with, based on their trade goals (sell or buy?; which commodity?; which quality?) and knowledge about potential partners. This information also plays an

important role during the process of negotiation. Once a contract has been agreed upon, the traders can either cooperate (deliver truthfully) or try and use an opportunity to defect. Upon delivery the receiver can either trust or put the delivery to the test, the latter usually at some cost where trust is for free. The delivery and trust decisions are based on personal preferences and cultural background, as well as on beliefs about the trade partner and the trade environment. Experience from the negotiation and delivery processes may change a trader's beliefs about the trade environment or about individual trade partners. The beliefs will, in addition to a trader's preferences, guide decision making in future trading. In this paper we limit ourselves to beliefs about trade partners. For this purpose three traits can be defined that trading agents maintain a belief about: fairness, trustworthiness, and benevolence. These beliefs are maintained for each trade partner. The belief about another agent's *fairness* represents an agent's expectation that a fair contract can be negotiated with the other agent. The belief about another agent's *trustworthiness* represents an agent's expectation that the other agent will deliver according to contract. The belief about another agent's *benevolence* represents the expectation that the other agent will accept deliveries without putting them to the test, in other words that the other agent will trust.

The power distance dimension has its effect on behavior in trade. The relevant issues are a trader's cultural background in a hierarchical or egalitarian society and the status or rank difference with its partner that an agent experiences against this cultural background. The following subsections specify the expected behavior with respect to these issues for each trade process.

Negotiation Behavior. Traders from small power distance cultures may have different ways to negotiate, but they will always negotiate. Traders from large power distance cultures on the other hand are not used to negotiating seriously. The powerful dictate the conditions. The less powerful have to accept. In cultures of large power distance that are also feminine or collectivistic the powerful may exercise restraint, or the lower ranked may successfully plead for compassion, but this is not a common decision making process, like a negotiation. The most powerful decides. When people from hierarchical cultures are forced to negotiate, because they are in a position of equal status or trade with foreigners, the negotiations often end in a game of power.

A trader from a culture with large power distance expects a lower ranked business partner to accept his conditions rapidly. If the lower ranked partner has the same cultural background, there is no problem and the rights of the higher ranked partner will be recognized and respected: the lower ranked opponent will be modest and give in easily. However, a trader from an egalitarian culture will not give in to the pressure if his status is lower, but will either react furiously (e.g., break off negotiations) or simply ignore the pressure (make a counterproposal), in which case the opponent will be furious (and e.g., break off negotiations).

If a trader from a culture with large power distance negotiates with a foreigner and assumes the foreigner to have a higher status, he may give in more easily than the foreigner expected. In that case the foreigner will be happy, but his opponent will have "left money on the table". If both are from hierarchical cultures but do not perceive one another's hierarchical position they may make misattributions resulting in one of them being dominated or stopping the negotiations.

Trade Goal Selection. Traders having a cultural background of small power distance opportunistically trade both low and high quality commodities and have a risk attitude that is not particularly influenced by power distance.

In hierarchical societies there are differences in selected trade strategy. The higher ranked prefer to trade high quality valuable commodities to underline their status that fits their position in life. They will not avoid deals where less powerful opponents technically have the opportunity to defect, because the higher ranked rely on their power to enforce cooperation.

The lower ranked have three incentives to prefer trade in low quality commodities in hierarchical societies. First, they know their place. Second, they are poor. Third, they may be cheated by high status opponents that make improper use of their power when trading valuable commodities; the lower ranked can avoid the risk of being deceived by trading commodities that have little appeal for higher ranked.

Maintenance of Beliefs about Partners. If counterparts have equal status, like in egalitarian societies, the experience of previous deals counts, be it personal experience or the experience of others (reputation). Failed negotiations decrease partner's future acceptability, and negotiations resulting in an agreement increase it for egalitarian traders.

In case of status difference in hierarchical societies, the acceptability of trade partners does not depend on experience in previous deals: the lower ranked have no choice but to accept business conditions and to show truthful and trusting behavior, whatever experience they have and whatever the reputations of their opponents are. So a lower ranked trader may have a belief about the fairness and trustworthiness of a higher ranked trader, but cannot show distrust. However, he may avoid a powerful trader that he believes to be unfair or untrustworthy... In a hierarchical society a trader of lower status forced into an adverse agreement by one of higher status will of course not find the opponent more acceptable afterwards, and try harder to avoid the opponent.

This cultural scripting may have its repercussions in intercultural trade. A lower ranked trader from a hierarchical culture might avoid a foreign trader if he assumed that his lower status did not allow him to negotiate successfully. A higher ranked trader from a hierarchical culture might overplay if he assumed that a foreigner would recognize his status and comply with his demands. An egalitarian trader who did not sufficiently respect the status of a hierarchical partner might fail to do business.

Truthful or Untruthful Delivery. After an agreement has been reached, it comes to delivery. If the quality of the commodity is invisible at first sight, the supplier can be opportunistic and deliver a lower quality product than agreed upon, thus making an extra profit. By doing so, regardless of the society's power distance, the supplier takes the risk of serious damage to the relation with the customer if the deceit be revealed.

For egalitarian traders, decisions to deceive, trust, and forgive are not influenced by their partner's status. Instead they depend on the quality of the relations they want to maintain and the sanctions they may expect.., In hierarchical societies, the higher ranked do not have to fear for repercussions when trading with lower ranked opponents, so the decision whether to defect or not merely depends on their morality, relationship, personality and/or circumstances. The lower ranked on the other hand will not easily consider to defect and will usually comply when trading with higher ranked and will only defect if in need. In collectivist societies, they would expect the higher ranked to recognize their need and to mercifully condone their behavior.

Trust or Trace. After delivery, the buyer may either request the delivered commodity to be traced, or accept it trustingly without tracing,.. In societies with large power distance, the lower ranked have no choice but to show trust in the higher ranked, whatever belief about their trustworthiness they may have. The higher ranked have no reason to distrust the lower ranked, because they assume that deceit of a higher ranked would not even be considered. So for the decision to trust, the belief about partner's trustworthiness is only relevant among equally-ranked or in relations where egalitarian traders are involved.

In intercultural contacts, the behavior of traders from hierarchical societies may be credulous in the eyes of their egalitarian opponents, because the high ranked rely on their status and the low ranked think it is improper to trace, thus encouraging deceit by the foreigners and eventually damaging the relation if deceit be revealed.

In egalitarian societies trust is equally important in every relation, regardless of partner's status. In these societies, decisions to trust a delivery or to request a trace (thus showing distrust) are not influenced by status difference. However, showing distrust may be harmful for relations, so there may be other incentives for benevolent behavior, but those incentives are not related to the dimension of power distance.

We assume that trust between parties will develop if negotiations succeed, even in the absence of positive evidence for the truthfulness of deliveries. On the other hand, a tracing report that reveals deceit will reduce trust.

Partner Selection. A trader has to select partners to deal with, either through response to a proposal made by another trader, or by proposing to another trader. Traders may use different criteria to select partners for new deals, according to their personal preferences and societal rules. The important criterion that differentiates partner selection across the power distance dimension is *status*.

In hierarchical societies traders will try to avoid partners who have higher status than they have themselves, because the higher ranked have the power to dictate business conditions. Traders will never propose business to higher ranked others because they are afraid of getting a bad deal. However, if they receive a proposal from a higher ranked trader they have to accept and the only thing they can do is plead and hope for magnanimity. Although one can exploit status in trading with less powerful counterparts, powerful traders in hierarchic societies prefer to do business with partners of their own level of power, because it would lower their status to get involved with people below their own standing.

In egalitarian societies status plays no role in partner selection. There are people who are labeled to have a high or low status in some respect like (show) business, politics, or sports. In strictly egalitarian societies, this will not influence the behavior of business partners. However in intercultural contacts, the traders from hierarchical societies may be influenced by the status labels of their egalitarian partners.

3 Representation in Agents

This section formalizes the knowledge about the influence of power distance on trade processes that was introduced in section 2. The relevant attributes of transactions from this viewpoint are the economic value of the transaction, the quality of the traded

goods as a status attribute in its own ("we deal in superior quality products only") and a perceived risk that the trade partner will not fulfill his or her contractual obligations. The latter is based on trust in the supplier and attributes of the transaction, including product quality: highly valued products such as organic food, designer clothes, and jewelry are a more likely target for swindle and counterfeiting than are commodities. The formalization is based on DESIRE [11], an agent specification language based on information type definitions, process composition, and production rules.

The negotiation process is simulated using the negotiation architecture of Jonker and Treur [12]. The architecture is based on utility functions for comparing bids and a set of decision parameters. In this case we use the following utility function. In other cases, other types of functions may be appropriate, possibly involving additional attributes. In such case, some of the rules given later in this section may have to be adapted.

$$U_{\text{bid}} = w_1 f_1(\text{value}_{\text{bid}}) + w_2 f_2(\text{quality}_{\text{bid}}) + w_3 f_3(\text{risk}_{\text{bid}}) \quad (1)$$

with $w_1 + w_2 + w_3 = 1$, and w_i in [0, 1] , for all i. f_1 presents the economic value of the bid in the interval [0, 1]; f_2 presents the additional value in [0, 1] that is attached in society to trading in high quality products; f_3 evaluates the risk of swindle of the transaction in [0, 1], with 1 representing a transaction without any risk.

Weight factors <w_1, w_2, w_3> characterize an agent's trade strategy, e.g., <*high*, *high*, *low*> represent an *opportunistic* strategy, <*low*, *high*, *high*> a *quality-minded* strategy, and <*high*, *low*, *high*> represent a *thrifty* strategy.

Traders in extremely egalitarian societies do not adapt their trade strategy to partner's status. Traders in hierarchic societies do. Lower ranked traders in hierarchical societies prefer a more thrifty strategy than the higher ranked ones. The higher ranked follow an opportunistic or quality-minded strategy, depending on status difference with their trade partner. Let the relation agent_trait_value: ISSUE × Real, stand for the natural inclination of the agent to weigh an issue. Then the effect of the power-distance and the status of both parties can be implemented as follows.

```
/* 1 calculate weight factors using PDI and status */
if cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and current_partner(C: Trader)
   and partner_model_contains_belief(C, status, Y: Real)
   and agent_trait_value(value_preference, P: Real)
   and agent_trait_value(quality_preference, Q: Real)
   and agent_trait_value(risk_aversion, R: Real)
   and N: Real = P + (1-H)*Q+H*S*Q + (1-H)*R+H*(1-S+Y)*R
then utility_weight_for_value( P / N )
   and utility_weight_for_quality( ( (1-H)*Q + H*S*Q ) / N )
   and utility_weight_for_risk( ( (1-H)*R + H*(1-S+Y)*R ) / N );
```

Traits, status, and power distance index are real numbers in [0, 1]. This rule represents that - in proportion with the power distance index - the weight that traders attribute to trading valuable high quality products relatively increases with their social status, while the weight they attribute to risk relatively decreases with increasing

feeling of superiority to the partner or increases with decreasing feeling of inferiority. The divisions by N normalize the sum of the weight factors to 1, so the weight of the economic value is indirectly affected by changes of quality and risk weights.

After evaluating a partner's bid with respect to value, quality, and risk, an agent has to decide whether to accept or to refuse the bid, and, in the latter case, whether to break off the negotiation or to make a counteroffer. Decision parameters are *utility gap* (difference of utilities that an agent will accept between partners' and own bid), *impatience* (probability that an agent will quit if utility or progress is low), *concession factor* (maximal relative concession with respect to the opening bid), and *negotiation speed* (maximal relative step toward maximal concession in a negation round). Furthermore, the rules use a *cut-off value* (minimal utility of partner's bid for which an agent continues) and a *minimal progress value* (minimal relative improvement of utility of partner's bids required in three rounds) as criteria to break off negotiations.

In the architecture of Jonker and Treur, agents accept an offer if the difference between partner's bid and their own bid is smaller than the *utility gap* parameter. As explained in section 2, negotiation in a hierarchical society is a game of power. The more powerful dictate the conditions of the deal. An agent from a hierarchical society feels forced to accept a bid of a more powerful partner even if the utility gap is not covered: the agent is aware that the utility of the bid would be unacceptable if it were made by a less powerful agent, but accepts.

```
/* 2 hierarchic agents accept sooner if partner is powerful */
if cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and current_round(X: Integer)
   and current_negotiation(C: Trader, X, L: Commodity_list)
   and partner_model_contains_belief(C, status, Y: Real)
   and agent_trait_value(acceptable_utility_gap, G: Real)
   and others_bid_utility_in_round(U: Real, X)
   and my_bid_utility_in_round(V: Real, X)
   and V-U < G * (1 + H * max(0, (Y-S)) * X )
then stop_negotiation(C, X, L, accept_offer);
```

Rules 3 and 4 express that in a hierarchic society an impatient agent will less likely break off negotiations with a more powerful opponent (suppressed impatience).

```
/* 3 have patience if powerful partners make unrealistic bids */
if cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and current_round(X: Integer)
   and current_negotiation(C: Trader, X, L: Commodity_list)
   and partner_model_contains_belief(C, status, Y: Real)
   and agent_trait_value(cut_off_value, M: Real)
   and others_bid_utility_in_round(U: Real, X: Integer)
   and U < M
   and agent_trait_value(impatience, I: Real)
   and random(0, 1, Z: Real)
   and I * (1-H*max(0, Y-S) ) * 0.5 > Z
then stop_negotiation(C , X , L, gap);
```

```
/* 4 have patience if powerful partners make no concession */
if cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and current_round(X: Integer)
   and X > 3
   and current_negotiation(C: Trader, X,  L: Commodity_list)
   and partner_model_contains_belief(C, status, Y: Real)
   and agent_trait_value(minimal_progress, M: Real)
   and progress_in_bids(X-3, X, P: Real)
   and P < M
   and agent_trait_value(impatience, I: Real)
   and random(0, 1, Z: Real)
   and I * ( 1-H*max(0, Y-S) ) * 0.5 > Z
then stop_negotiation(C, X, L, no-accom);
```

Rule 2 is about accepting partners' bids. A hierarchic agent also accommodates a more powerful partner by making greater concessions in his own bids. In the architecture of Jonker and Treur: decrease the *minimum utility* parameter (rule 5).

```
/* 5 hierarchic agents give in easily if partner is powerful */
if cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and current_partner(C: Trader)
   and partner_model_contains_belief(C, status, Y: Real)
   and agent_trait_value(concession_factor, F: Real)
then   minimum_utility ((1-F)*(1-H*(0.5*(Y-S)+0.5*abs(Y-S))));
```

The *negotiation speed* parameter, i.e. the relative size of concessions toward the minimum utility, is not influenced by power distance. However, the absolute size of concessions increases with power distance, because concession size is the product of negotiation speed and the difference between the previous bid's utility and minimum utility.

The following rule (rule 6) is about the delivery, once a deal has been closed. Contracts may leave room for opportunistic behavior such as delivering goods of inferior quality. The decision whether to defect or to cooperate is modeled as comparing the temptation to deceive with a threshold (*honesty*, an agent's personal trait). The temptation depends on factors like the product quality agreed in the contract. In hierarchic societies the threshold for defection is influenced by status.

```
/* 6 hierarchic agents are conscientious with a powerful partner */
if cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and current_partner(C: Trader)
   and partner_model_contains_belief(C, status, Y: Real)
   and agent_trait_value(honesty, T: Real)
then   deceit_treshold(T+H*(Y-S)*(1-T));
```

The agents maintain a belief about the trustworthiness of other agents, i.e. the probability that they will not deceive. However, the decision to trust does not depend on this belief only. The relevance of this belief depends on two factors. First, the product quality agreed in the contract influences the relevance: expensive, high quality products are more sensitive to deceit than cheap, low quality products.

Second, in hierarchic societies the relevance of interpersonal trust for the decision to put deliveries to the test (trace) decreases as status difference increases (rule 7, which is only relevant for contracts about high quality product transactions). Low status agents do not trace high status agents, because they do not dare to show distrust. High status agents do not trace low status agents, because they trust that the opponents of lower status will not dare to defect.

```
/*  7 hierarchical agents do not trace if status difference is big */
if deal_in_round(C: Trader, B: Bid, X: Integer)
   and current_round(X: Integer)
   and cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and partner_model_contains_belief(C , status, Y: Real)
   and partner_model_contains_belief(C , trust, T: Real)
   and random (0, 1, Z: Real)
   and (1-H*abs(Y-S))*(1-T) > Z
then  to_be_traced(B);
```

Beliefs about partners are updated, based on experience. For trustworthiness belief:

$$\begin{aligned} t_{C,x} &= (1-\delta^{+})\, t_{C,x-1} + \delta^{+}\, e_{C,x}\,, \ \text{if } e_{C,x} \geq t_{C,x-1}\,, \\ t_{C,x} &= (1-\delta^{-})\, t_{C,x-1} + \delta^{-}\, e_{C,x}\,, \ \text{if } e_{C,x} < t_{C,x-1}\,. \end{aligned} \tag{2}$$

with $\delta^{+} = \varepsilon\delta^{-}$ and δ^{+}, δ^{-}, and ε all in the interval [0,1] ; $t_{C,x}$ represents trust in agent C after round x; $e_{C,x}$ represents the experienced result with C in round x. $e_{C,x}$ is either 1 (partner cooperated) or 0 (partner defected). Note that the model does not reason about the cause of the experience, e.g. by maintaining beliefs about partner's competence and honesty; the only thing that counts is the effect.

A similar update function is defined for benevolence. Being traced reduces the belief in partner's benevolence and not being traced is perceived as a confirmation of trust.

The belief about fairness is maintained similarly. For fairness the utility of the deal is used as experience value, a broken negotiation having an experience value of zero. When selecting partners, egalitarian agents compare others with respect to fairness. Hierarchic agents also use fairness, but their priority is to avoid status difference (rule 8). However, they cannot refuse if a higher-ranked proposes to do business (rule 9).

```
/* 8 hierarchic agents avoid partners with status difference */
if no_ongoing_negotiations
   and not_recently_proposed_to_me (C: Trader)
   and cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
   and partner_model_contains_belief(C , status, Y: Real)
   and partner_model_contains_belief(C , fair, F: Real)
then acceptability (C,  (1-H*abs(Y-S))*F);

/* 9 high-ranked partner is hard to refuse for a hierarchic agent */
if no_ongoing_negotiations
   and recently_proposed_to_me (C: Trader)
   and cultural_script_contains(power_distance_index(H: Real))
   and agent_label(status, S: Real)
```

```
    and partner_model_contains_belief(C, status, Y: Real)
    and partner_model_contains_belief(C, fair, F: Real)
then acceptability (C, (1-H*abs(Y-S))*F + H*max(0, Y-S));
```

Details of partner selection that are not related to specific cultural dimensions are given in [1].

With respect to the decision making presented in this section the following must be noted. According to March [13], decision making can be modeled as either rational or rule-following. Equation (1) may suggest that the agents are modeled as rational utility maximizers. To some extent they are, as the first term of the function represents economic value of the transaction, e.g. the profit that a trader expects to gain based on market price beliefs and calculated risk. However, the other terms of equation (1) represent deviations from economic rationality that may be influenced by a trader's personality and culture. The second term represents an economically irrational preference for quality, for instance for dealing in luxury products in a situation where more profit can be made by dealing in standard products. The third term represents a risk aversion that goes beyond the calculated risk accounted for in the economic value of the transaction. Furthermore, the utility function is only used to valuate and compare bids during the negotiation process. All decisions about partner selection, accepting a bid, continuation of negotiation, deceit, and trust are modeled to be rule-following in the terminology of March.

4 Experimental Verification

The production rules formulated in the preceding section were verified in two steps. First, the formulation of the rules was verified in one-to-one agent scenarios. The rules were verified by step-by-step observation of the actions (duration of negotiations, quality levels and utilities of closed deals, break-off, trust and deceit decisions, and belief update) for different values of power distance index and status difference. Secondly, as DESIRE is not a suitable environment for simulating larger populations of agents, for verification of emerging properties at the macro level the agents were implemented in a multi-agent environment. For this purpose, CORMAS was chosen. CORMAS is a Smalltalk-based tool for multi-agent simulations that facilitates simulation with larger populations [14]. The verification results at macro level are discussed in this section.

Table 2 presents results of multi-agent simulations in single-culture and multicultural settings. Agents have the role of either supplier, customer, or tracing agent. In time step 1 the customers send a proposal to a supplier of their choice. In each next time step the trading agents may wait for a reply when they did send a proposal in the previous time step, or they may either reply with an acceptance message or a counter proposal, or ignore received proposals and take the initiative to send a new proposal to a preferred potential partner. If a deal has been closed, the supplier delivers and the customer may accept the delivery or forward it (at the cost of a fee) to the tracing agent. The tracing agent tests the quality, returns the delivery and reports its findings to the customer and the supplier. In case of deceit the tracing agent fines the supplier.

Table 2. Number of successful transactions in runs of 100 time steps. The agents are divided into two groups of four suppliers (S1 and S2) and two groups of four customers (C1 and C2). All agents have equal parameter settings, except power distance and status that may differ across groups. H stands for hierarchic cultural background (power distance index = 0.99); E for egalitarian (p.d.i. = 0.01); S for superior status (status = 0.8); I for inferior (status = 0.2).

	run#	S1	S2	run#	S1	S2	run#	S1	S2	run#	S1	S2
run#	1	HS	HS	2	HI	HI	3	HS	HI	4	ES	EI
C1	HS	11	12	HI	8	10	HS	36	1	ES	17	13
C2	HS	19	13	HI	12	10	HI	0	23	EI	10	13
run#	**5**	ES	EI	**6**	HS	HI	**7**	EI	EI	**8**	ES	ES
C1	HS	33	0	ES	20	11	HS	10	14	HS	14	16
C2	HI	0	30	EI	5	13	HI	9	14	HI	16	17
run#	**9**	ES	EI	**10**	HS	HS	**11**	ES	EI	**12**	HI	HI
C1	HS	23	0	ES	20	13	HI	1	21	ES	10	11
C2	HS	26	0	EI	10	10	HI	1	24	EI	14	11

The results illustrate that the ease of trade depends on trader's status in hierarchic societies (runs 1 and 2). Trade stratifies according to status in hierarchic societies, but not in egalitarian ones (3, 4). In mixed settings stratification occurs especially when the hierarchic make the first proposal (5). Stratification is reduced when egalitarians make the first proposal, especially for the lower classes (6). When hierarchic traders have no choice but to trade with egalitarians they do so (7, 8). However, when given the choice they prefer peers (9-12). These results demonstrate that realistic tendencies emerge from interactions of agents following the rules specified in this paper.

5 Conclusion

There is a wealth of literature on trade and culture that so far has not been considered in formalized models of trade. In agent-based economics, individual traders are modeled as intelligent agents cooperating in an artificial trade environment. The agents are modeled to mimic authentic human behavior as closely as possible. In recent papers the differences between such agents is no longer solely attributed to differences in their individual economic situations. Aspects such as personality and attitude are considered as well, see for example, [15]. Without considering such aspects, the simulations will not correspond to reality. With respect to formalizing the important influence of cultural background on trade, we only found a few papers. These papers study trade at the macro-level. An example is [16]. This paper presents an equilibrium analysis on the amount countries invest in learning another language and culture and the size and welfare of those countries. Another example is [17]. That paper presents a formal model of the influence of trade on culture, i.e., the reverse direction of influence as studied in the current paper. Other literature also uses macro-level models, such as the gravity model to study the correlation between culture and trade, e.g., [18].

Most agent models of culture that can be found in the literature aim to adapt system behavior and user interfaces to the user's culture. Kersten [19] urges the necessity of cultural adaptation of e-Business systems and proposes an architecture that adapt both business logic and user interface. The rationale for adapting systems to user's cultures is given by Kersten et al. [4], who report significant differences in expectations, perception of the opponent, negotiation process, and outcomes of electronic negotiations across cultures. However, no actual implementations of models of culture in e-Business have been found to be reported. Blanchard and Frasson [20] and Razaki et al. [21] report an application of Hofstede's dimensions in a model to adapt e-Learning systems to the user's culture. Recent research on cultural modeling in agents mostly focus on Embodied Conversational Agents (ECA), including non-verbal behavior like facial expressions, gestures, posture, gazing, and silence in conversations; see, e.g., [22, 23]. For instance, the CUBE-G approach of Rehm et al. [24, 25] is based on the Hofstede dimensions and focuses on modeling into virtual characters the processes of first meeting, negotiation, and interaction in case of status difference.

All models discussed so far have in common that they model culture with the purpose to support human decision making or to improve human-computer interaction. The purpose of the model proposed in the present paper is to realistically simulate emergent behavior in multi-agent based simulations for research in the social sciences. The aspects of ECA are of less relevance in this context. Agent behavior may be modeled in a more stylized way. An approach that does so for the purpose of multi-agent simulations is that of Silverman et al. [26, 27]. They model agents as a composition of biological, personal (personality, culture, emotions), social (relations, trust), and cognitive (decision) modules, completed with modules for perception, memory, and expression. Their approach is a generic structure for modeling the influence of culture on agent behavior – along with factors like stress, emotion, trust, and personality – through Performance Moderator Functions (PMF). It differs from our approach in that it is an environment to implement validated models of culturally differentiated behavior, while our approach aims to develop and validate such models.

The contribution of this paper is the formalization of culture with respect to the influence of the power distance dimension on trade. This formalization has been carried out at the micro-level, i.e. at the level of individuals participating in trade. The traders' behavior is formalized in the form of rules that take power distance and status difference into account. The agents reason with a perceived model of the parties they consider for trading. These perceived models do not contain estimates of the culture of the other parties. Furthermore, the rules do not model the motivations and emotions that underlie the behavior. However, for study of macro-level effects as a consequence of cultural differences in micro-level interaction it is sufficient that the rules realistically model the effects of culture on individual behavior.

The work of Hofstede [8] offers detailed information to model the effect of culture on human behavior. Hofstede's model is based on a thorough statistical analysis of a massive amount of data. The five dimensions of culture discovered by factor analysis of the data are an efficient instrument to type national cultures. For each of the dimensions Hofstede's work offers extensively validated descriptions of difference in behavior along the dimensions. These descriptions are very well applicable to modeling differences in behavior of artificial agents.

The approach taken in this paper is to model a single one of Hofstede's dimensions. The other dimensions are treated in other work [1, 28, 29, 30]. Modeling a single dimension of culture is artificial. In reality, all aspects of cultural background have their effect simultaneously. However, modeling behavioral differences for a single dimension offers the possibility develop narrative descriptions of hypothetical behavior as presented in section 2 of this paper, to implement this behavior into agents, and to verify if the aggregated effects correspond with the expected behavior on the basis of Hofstede's theory. The results of the simulations presented in section 3 demonstrate that realistic tendencies emerge from interactions of agents that follow the rules specified in this paper.

Future work aims to integrate models for the separate dimensions into agents with believable culturally differentiated behavior, and to validate and calibrate the integrated models in two ways. First, business, economics, and negotiation science literature offer hundreds of papers that describe and analyze differences between cultures and intercultural interactions. Second, gaming simulations like [2] can be used to validate agent model behavior in specific configurations.

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