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The Influence of Culture on ABMP Negotiation Parameters

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Abstract Negotiations are known to proceed differently across cultures. A realistic agent model of international negotiations has to take cultural differences into account. This paper presents an agent-based model that tackles this challenge. The context is a trade game where commodities with a hidden quality attribute are exchanged. The negotiation model uses the ABMP negotiation architecture. It applies a utility function that includes market value, quality preference, and risk attitude. The indices of the five dimensions of Hofstede's model of national cultures are used, in combination with agent's group membership and societal status, to differentiate negotiation behavior by adaptation of weight factors in the utility function and ABMP parameters. The paper presents test runs with synthetic cultures and a set of actual national cultures. The present version of the model helps to understand behaviors in international trade networks. It proves that Hofstede's dimensions can be used to generate culturally differentiated agents.

Introduction

Bargaining practices differ across the world. Multinational companies sometimes work with different price lists for different countries: in order to sell at the same price, the selling company needs to adapt its offer to the varying bargaining practices. A single piece of advice about how to bargain, or a single model to describe bargaining, are obviously not valid across the world unless culture is taken into account.

'Culture' is a notion with many meanings, some of which are contested in some disciplines. However, the leading paradigm today is widely accepted and used in both practice and academia. According to it, culture refers to the *unwritten rules of society*. It is a phenomenon that is specific to a group, not to an individual. It is

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transmitted in early youth through example and education. As a result its stable across centuries in spite of huge changes in environment and technology. Cultural differences show no signs of diminishing in the Information Age.

Within the literature various basic dimensions can be found according to which societies differ from one another. Of these, the most widely used is Hofstede [1], [2]. His work is accessible, sparse, and based on a very large, very well stratified sample that continues to give it great explanatory value. No other model matches society-level variables so well to date [3].

This paper describes an agent-based model for bargaining in the context of trade and focuses on cultural adaptation of negotiation process parameters. The agents follow common sense strategies such as maximizing utility, seeking good quality, and minimizing risk, but they also have models of how to behave in an appropriate manner. The latter models are based on Hofstede's five dimensions of culture. A cultured agent-based model of bargaining offers several promises. It can help understand the dynamics of international negotiations in trade. It could also serve as a training tool for aspiring international traders.

The paper first briefly introduces Hofstede's model of five dimensions of culture. Next, the ABMP (Agent-Based Market Place, [4]) negotiation model that we adopt is presented. We show how this model can be used in agent-based simulations. We also discuss the limited subset of negotiation situations that are considered in this article. In the third section we link culture and negotiation by describing the influence of each of Hofstede's dimensions of culture on negotiators' practices and preferences. This section sets the scene for the presentation of the rules for our cultured agents in the fourth section. Section five shows example runs with the model on imaginary cultures that have extreme values on one of the Hofstede dimensions and average values on the other four. Section 6 presents results of test runs for a set of actual countries. Finally we discuss the model and how to proceed, since this model forms the basis of future research and tools.

Hofstede's Five Dimensions of Culture

Human societies have found a different patterns of response to the problems of social life. In some, groups are permanent and close-knit while in others, group membership is volatile and voluntary. In some, leadership style is usually autocratic and in others, participative. Research has shown and repeatedly confirmed that basic tendencies to deal with a few central issues of social life are stable across the generations in societies [2]. They are, because they are instilled into a society's members from birth. As a baby and as a toddler, a child is primed as a social being. Once a child sets foot into the wider society as a teenager, its basic cultural orientation is firmly in place. This research stream has led to dimension models of culture. The most widely used of these is the five-dimension model by Hofstede [1]. The five dimensions are:

– *Identity*: individualism versus collectivism. Essentially this is the extent to which members of a society feel responsible for themselves and close relatives,

or for the larger group they belong to, and feel the group to be responsible for them.
- *Hierarchy*: large power distance versus small power distance, or the extent to which the less powerful members of a society expect and accept that power and rights are distributed unequally.
- *Aggression and gender*: masculinity versus femininity. This dimension is about assertive dominance and emotional gender roles. A firm, competitive orientation, versus a consensus-seeking and care-taking orientation, for both women and men.
- *Otherness and truth*: uncertainty avoidance versus uncertainty tolerance. In uncertainty avoiding societies strict rules, rituals, and taboos govern life. Distinctions should be sharp and the unknown is considered dangerous.
- *Gratification of needs*: sort-term versus long-term orientation. In some societies immediate gratification of needs and keeping up social appearance, well-behaving and respect for tradition are seen as virtues. In long-term oriented societies, reasoning is pragmatic and planning, foresight and perseverance are valued.

Note that the five dimensions are not personality traits, but societal patterns! Also note that the picture drawn is necessarily simplified. It presents the two caricatured extremes of each dimension. In reality, almost all cultures have intermediate positions on almost all dimensions. Furthermore, the dimensions of culture can only be isolated from one another in an artificial way. The five dimensions are no more than abstractions that capture main behavioral trends. In reality, cultures have a recognizable feel to them, a Gestalt that can be described, albeit only roughly, by its combination of dimension scores. Experienced negotiators know the range of behaviors that they can expect from negotiators from other parts of the world. They also know how gender, age, status and personality can affect the negotiation style of people from these parts of the world.

In [5], [6], [7], [8], [9], the influence of each of the dimensions on trade processes was modeled separately; a slightly artificial, but also necessary intermediate step to model agents differentiated along the Hofstede dimensions. This chapter describes a reconciled models of all dimensions and presents test runs with synthetic and actual national culture.

Negotiation Process Model

The present work focuses on a specific type of negotiations: bilateral bargaining about business transactions. The work aims to develop models of actual human behavior. It does not aim to develop an optimal bargaining strategy that can outperform human negotiators or other agents.

In bilateral negotiation, two parties aim at reaching a joint agreement. They do so by exchanging various offers or bids using e.g. an alternating offers protocol [10] called the “negotiation dance” in [11]. Negotiation is a complex emotional

decision-making process aiming to reach an agreement to exchange goods or services [12].

The literature on automated negotiation contains a number of agent models for negotiation. The focus of that literature is on reaching deals that are Pareto-efficient (i.e., neither can improve without making the situation worse for the other). Furthermore, some aim at reaching fair outcomes, i.e., in which the deal is equally good for both parties. For more information on strategies see, e.g., [4], [13], [14], [15].

The context of the negotiation behavior modeled in this paper is formed by human gaming simulations. The gaming simulations are designed as tools in supply chains and networks research [16]. The multi-agent model aims to simulate human behavior in these games. Fig. 1 depicts the process model of an agent's activities in the game.

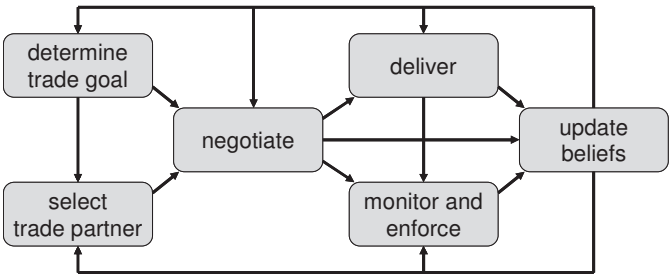

Fig. 1. Processes and internal information flows of trading agents

Participants can determine their trade goals, for instance to sell or to buy commodities of a particular quality level. They can select a trade partner according to their preferences and experience, negotiate a transaction of a commodity with quality attributes and guarantees, and deliver truthfully or defect. The essence of the game is information asymmetry: commodities have a quality attribute that is known to the seller and invisible – but testable at some cost – for the buyer. The buyer can either trust the seller's quality statement or spend money on testing, or negotiate some kind of guarantee or certification, which will result in a higher price.

The relevant attributes for comparing bids during the negotiation process are the economic value of the transaction according to market prices, the valuation of particular quality attributes by the trader, and the risk of deceit introduced by the information asymmetry.

The valuations of quality and risk have a rational component and a subjective valuation that is influenced by a trader's personal characteristics and culture. The rational component of a quality attribute is the difference in market price that a trader expects as a result of the quality difference. The rational component of the risk is the product of the amount of the damage and the probability that the damage occurs. The subjective valuation comes in addition to the rational value. For quality, it is the trader's quality preference, for instance because of the societal status that results from trading high quality products. For risk, it is an agent's risk

aversion, a cost in excess of *damage×probability*, that a trader is willing to make in order to avoid risk.

In the models developed in this work, traders are assumed to compare business proposals by applying a utility function as proposed by Tykhonov et al. [17]:

$$U_B = w_v V_B + w_q Q_B + w_r R_B \; . \tag{1}$$

U_B stands for the utility that agent a expects from bid b made by partner agent p.

V_B reflects a's belief about the economic value of the transaction in the interval [0, 1]. It is calculated as the profit expected from the transaction in case of cooperation, minus the estimated risk of the trade partner to defect, computed as *damage×probability*.

Q_B reflects the subjective valuation of the quality attribute of the proposed transaction, in addition to the market value, in the interval [0, 1], e.g. a trader may prefer trading biologically grown food, even if more profit can be made trading traditionally grown.

R_B reflects a's valuation of the risk involved in the interval [0, 1], with 1 representing no risk. It is based on the product of three factors, all normalized values in the interval [0, 1]. The first factor is a's subjective estimate of the probability that p's will defect. The second factor is the opportunity to defect that the contract leaves for p, e.g. a contract for organically grown food offers the opportunity to deliver the cheaper traditionally grown, but a contract for traditionally grown food does not. The third factor is the damage that a expects to suffer in case of defection by p, normalized in the interval [0, 1] with 1 representing maximal damage. R_B is computed as the product of the three factors.

The factors w_v, w_q, and w_r, with $w_v+w_q+w_r=1$, reflect the weight that agent a attaches to the terms of the utility function when dealing with p. For a rational agent, $w_q=w_r=0$. The values of w_q and w_r reflect an agent's quality preference and risk aversion, and are to a great extent influenced by culture. Within a culturally homogeneous society, not all agents have equal preferences, but significant differences between cultures exist in the average values of risk aversion and the appraisal of status associated with high quality products.

Technical details of the utility function can be found in [18].

ABMP Negotiation Architecture

For the agents' negotiation strategy we chose the Agent-Based Market Place (ABMP) architecture of Jonker and Treur [4], because of its proven similarity to human negotiations [19] in experiments with the SAMIN system of which the bidding strategy is that of ABMP.

The ABMP strategy is developed on the following principles. To assess a bid of the other party, it is important to have evaluation methods. Evaluation can be done at two levels: the level of each of the specific attributes (attribute evaluation), and

the level of the bid as a whole (overall bid utility). Thus, some characteristics of ABMP are:

- explicit reasoning about the negotiation strategy and co-ordination of the negotiation process;
- evaluation of a bid takes into account both the attributes separately and the overall utility of the bid;
- planning of a new bid takes into account both the overall utility level and the level of attributes separately.

In particular, in the model it is possible to work on two levels: the level of the overall bid and the level of each of the attributes separately. The negotiation model has been specified as a compositional structure within the component Co-operation Management of the agent, see Figure 2.

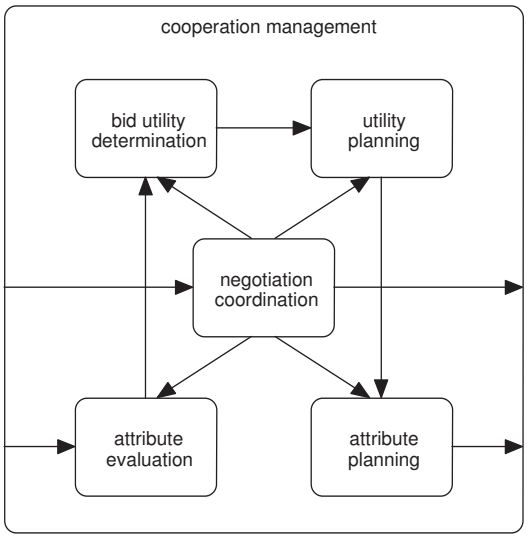

Fig. 2. Multi-Attribute Negotiation Architecture

Globally speaking, the process runs as follows:

1. At the beginning of each negotiation round, evaluations of the attributes of the previous bids are determined.
2. The evaluations are aggregated and the overall utilities are computed, both for the own previous bid of the agent and the proposed bid, received from the opponent in the previous negotiation round.
3. Decide whether to accept the opponent's bid, quit the negotiation without a deal, or make a counteroffer. For a counter offer the next step is, step 4.
4. The concession step to be made in the next bid is determined. For this, the agent determines the overall target utility for the next bid to be proposed to the opponent.

5. To obtain the next bid, given the target utility, first according to some distribution over attributes, target attribute evaluation values are determined (chosen in such a manner that they aggregate exactly to the target utility).
6. Finally, for each of these target attribute evaluation values, an attribute value is chosen that has an evaluation value as close as possible to the target evaluation value for the attribute

An agent accepts another agent's bid, unless:

- *Repetition of steps* takes place: steps without enough progress (depending on the impatience factor (π) which specifies the acceptable number of steps in which nothing changes)
- A *utility gap* (larger than some threshold ω) remains; i.e., a significant difference between the utility of the own bid and that of the other agent's bid.
- A *configuration mismatch* (larger than some threshold ν) remains between the own bid and the other agent's bid.

Here a configuration mismatch means that for at least one attribute, between the two values (in the two bids) a significant difference exists. Depending on the outcome of the analysis in step 2, component Negotiation Coordination decides on the next action (step 3). If a user is involved, the agent involves the user in the decision process. If the agent is solely responsible for the negotiation, it decides for itself on one of the following actions:

- Start a next negotiation round
- Contact the user (to discuss whether the concession factor (γ) can be changed.
- Contact the user to discuss whether the configuration tolerance (τ) can be changed.
- Communicate to the user that an agreement has been reached.
- Communicate to the user that the negotiation has failed (only when the user is unwilling to change the characteristics).

One additional elementary aspect of the ABMP architecture is the determination of a concession step (step 4). This step characterizes a concession-based strategy. The decision for what concession to make is based in ABMP on the concept of the current utility gap, i.e., the difference between the utility of the agent's own bid, and the utility of the last bid of the opponent. It is important to note that in this computation both utilities are based on the agent's own utility function. Thus, where the utility of the self (own) bid is the actual, true utility value, the utility of the opponent's bid is typically only an approximation, since the opponent is typically not willing to share his utility function. This illustrates a key aspect of negotiations with incomplete preference information (i.e., where the utility function of the opponent is unknown): the perceived remaining utility gap between the own and other's offer may be very from the perspectives of the two parties. A concession made by one agent (in the way of decreasing his own utility function) may be perceived as no concession at all (even a retraction) by the other party. Similarly, an agent can make no concession (or a very small concession), but the opponent perceives this concession as very considerable. It is precisely this type of concessions that one would like to achieve in multi-attribute negotiations, since it means

the new offer is closer to the Pareto-efficient frontier. Such concessions can only be achieved by finding suitable concession trade-offs between the issues.

In ABMP the concession step *CS* is determined by

$$CS = \beta (1 - \mu / U_{BS}) (U_{BO} - U_{BS}) . \quad (2)$$

In the above formula, U_{BS} and U_{BO} represent the utilities of self (i.e., the agent's own bid), respectively the utility of the other's last bid. The factor $U_{BO} - U_{BS}$ expresses the current *utility gap*. The letter μ stands for minimal utility, also known as reservation value. The factor β stands for the *negotiation speed*. The minimal utility is taken as $\mu = 1 - \gamma$ with γ the *concession factor*, expressing a measure in how far concessions can be made. The factor $(1 - \mu / U_{BS})$ expresses that the concession step will decrease to 0 if the U_{BS} approximates the minimal utility μ. This ensures $U_{BS} \geq \mu$.

Note that in step 4, the user is asked whether he is willing to adjust his concession factor. The rationale for this is that, in human negotiations, often the players do not know their true or absolute cut off value (minimal utility), but start working from a higher value. If it turns out that with that somewhat higher minimal value, they cannot close the deal, humans tend to adjust this minimal value closer to their true cut off value.

The rest of the ABMP architecture is not explained in this paper, as it is not fundamental for understanding the current paper. For more details, the reader is referred to [4] and [20].

Culture and Bargaining

[5], [6], [7], [8], and [9] model the influence of culture on trade processes for each of the five dimensions separately. Characteristic effects of the dimensions on negotiation behavior are cited below.

Individualism versus collectivism

According to [5], to a collectivistic trader, negotiation has to be preceded by the formation of a relationship. If that goes wrong there is no negotiation. During the negotiation, collectivistic traders discriminate between in-group and out-group partners. They try to maintain harmony as long as the opponent follows the in-group rules. When doing business with individualist traders the collectivists may be shocked by their opponent's explicit communication. The style of the reaction may be furious, or they might never explicitly say anything, but just avoid the other from now on. In a collectivistic culture the responsibility for in-group welfare and the compliance with in-group rules always play a prominent role. A collectivist will accept benefits for his in-group rather than his personal advantage as a convincing argument.

Individualists have one thing in mind during negotiations: their personal interest. So individualist traders are not very modest in their negotiations, nor will they give in for the purpose of maintaining harmony. If they are not aware of the cultural differences when trading with collectivists, they may be upset by the lack of explicit communication, or they may upset their opponents by being too explicit, or by talking business before the relationship has been established and acknowledged. They behave patiently as long as it serves their interest.

Power distance

According to [6], traders from egalitarian 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. 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 will be recognized and respected: the lower ranked will be modest and give in easily. However, a trader from an egalitarian culture may 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).

Masculinity versus femininity

[7] treat the dimension of masculinity versus femininity as a preference for performance versus cooperation. A performance oriented trader (masculine culture) is interested in fast trades, with as many high quality goods as possible in one trade. This trader is rather impatient, and if bids are too far off from his profile, he will walk away quickly. The performance oriented sticks to the contract of the deal, deceive the trade partner to the limits of the contract without any compunction, and expects the partner to do so too.

A cooperation oriented trader (feminine culture) is interested in the relationship with the trade partner; building trust is important. The amount or quality of goods is not of the most interest, because the relationship built during negotiation might pay off in future negotiations. Given the interest in the relationship with the trade partner, a first negotiation with a trade partner will take time that is willingly spent. During such negotiations, the trader appreciates a negotiation process in which both partners show a willingness to accommodate the other over time.

Uncertainty avoidance

According to [8], the first bid of an uncertainty avoiding trader tends to be modest in the sense that it is a price he thinks is right. Uncertainty avoiding traders have

an emotional style of negotiation, making sure that the opponents understand their feelings. They will not adapt their behavior to their opponent's. In the bargaining that follows they will not easily give in nor will much time be spent. After a few unsuccessful iterations, the uncertainty avoiding trader will break off the negotiation.

Uncertainty tolerant traders on the other hand have a relaxed style of negotiation. They try to adapt their behavior to their counterparts, although they are not prepared to come to an agreement at all cost. They do not show their emotions and may be disconcerted if their opponents do. They are careful not to be more yielding than their counterparts are.

Long term versus short term orientation

According to [9], long term oriented negotiators are pragmatic and take the bigger picture. They tend to see one bargaining instance as a small step in a long process, and their decisions will be led by their estimation of the profitability or other success chances of that longer process. Long-term oriented traders show patience. They do not break off negotiations. They do not overcharge. A first proposal may be modest, but they do not rapidly give in.

Short term oriented negotiators, on the other hand, think in terms of moral principles and apply them to the situation that is before them here and now. They are very reliable when it comes to following standards of appropriateness of behavior, but this can make them disregard the ulterior consequences of their action.

Modeling Culture in ABMP

Based on narrative descriptions acquired through an expert systems knowledge elicitation approach, [5], [6], [7], [8], and [9] propose formal models for the influence of the single dimensions on the ABMP parameters, and for the weights that subjective terms for quality preference and risk aversion get in an agent's utility evaluation.

With respect to the influence of culture, the relevant ABMP parameters are concession factor, negotiation speed, utility gap size, and impatience factor. The concession factor determines how far the agent is willing to go in making concessions. Negotiation speed determines the extent of concessions to its own utility the agent would typically make per negotiation round. The utility gap size expresses what is acceptable to the agent when comparing its own bid with that of the opponent. If the difference in utility falls within the utility gap size, the agent will accept the opponent's offer. The impatience factor determines when the agent becomes impatient with the opponent. For example, for some agent it is OK if the other makes a concession within 4 rounds, for another, the opponent should make concessions every round.

Table 1. Influence of culture on the utility weight factors and ABMP parameters (+ increased parameter value; - decreased; +! increased every negotiation round) [18]

Culture type	Relation	w_q	w_r	γ	β	ω	ι
large power distance	self status high	+					
	self status low	-					
	higher partner		+	+		+!	-
	lower partner		-				
small power distance							
uncertainty avoiding	similar partner	+	+		+		+
	different partner	+	++		+		+
uncertainty tolerant							
individualistic							
collectivistic	ingroup partner			+			-
	outgroup partner		+		-		
masculine		+	+		+		+
feminine		-			-		-
long-term oriented		-					-
short-term oriented	general	+					
	high partners	+	-	+			-

[18] proposes a model that integrates the models of the single dimensions into a five-dimensional model of cultural influence. The basis for the integration is the table of cultural factors' influences (Table 1).

The modeling approach is as follows. Behavior is influenced by the cultural dimensions. These are represented by indices usually called PDI, UAI, IND, MAS, and LTO. We scale these indices to the interval [0, 1], 0 representing the lowest observed valuein surveys of national cultures, 1 the highest observed value, and indicate the scaled values by PDI^*, UAI^*, IND^*, MAS^*, and LTO^*, respectively. So, IND^* indicates the degree of individualism, 1-IND^* indicates the degree of collectivism.

In addition to the indices, in some cultures relational characteristics are relevant to differentiate behavior. In cultures with high power distance, status of the agent and its opponent is relevant. In collectivistic cultures, in-group members are treated differently from out-group members. In uncertainty avoiding cultures, strangers are mistrusted. In short-term oriented cultures, celebrities and well-respected members of society are treated with special attention.

The combination of cultural indices and relational characteristics lead to the cultural factors represented in Table 1. These factors are modeled to have a monotonous effect, either increasing or decreasing, on the relevant ABMP parameters and weight factors. As no further evidence is available, a simple approach is taken and the effects are assumed to be linear: from some default value to a minimal value if the resulting affect is negative; from the default value to a maximal value if the effect is positive:

$$x = x_T + \frac{\Delta x + |\Delta x|}{2}(x_H - x_T) + \frac{\Delta x - |\Delta x|}{2}(x_T - x_L) \ . \tag{3}$$

In the above equation x_T represent the default value of parameter x, x_H the maximal value, x_L the minimal value, and Δx the effect of joint cultural factors on x.

The effects of the factors on a parameter are computed by subtracting the weak disjunction of the decreasing effects from the weak disjunction of the positive factors. So, positive effects cannot reinforce each other, negative effects cannot reinforce each other, but the strongest negative effect can compensate for the strongest positive effect, vice versa. This can be illustrated by the effect of culture on the impatience parameter:

$$\Delta\iota = \max\left\{UAI^*, MAS^*\right\} - \max\left\{\begin{matrix} PDI^*\left(s_p - s_a\right), \left(1 - IND^*\right)\left(1 - g_{ap}\right), \\ \left(1 - MAS^*\right), LTO^*, \left(1 - LTO^*\right)s_p \end{matrix}\right\}. \qquad (4)$$

In this equation s_a and s_p represent the agent's beliefs about own and partner's societal status, respectively, and g_{ap} represent a's belief about group distance with p . Effects on other parameters are computed similarly, using Table 1.

Test Runs with Synthetic Cultures

Table 2 presents results of simulated negotiations, applying Jonker and Treur's ABMP architecture [4]. The negotiations are performed in the simulation environment for of commercial transactions, applied in [6], [7], [8], and [9]. The agents are assigned roles of either suppliers or customers. Agents may select a partner in the opposite role and negotiate about the sale of a commodity that has either high or basic quality. However, quality is not visible without third-party testing, so the buyer of a high quality product has to accept risk, i.e. trust the seller. In the current simulation, agents are neutral with respect to trust, i.e. neither trust nor distrust their trade partners. If they agree on high quality, they implicitly accept the risk of deceit. The percentage of high quality transactions reflects the level of risk that the agents are willing to take. It should be noted that the results are not tuned to realistic situations. The figures should not be taken as absolute values. They show tendencies that emerge from the model.

The results in Table 2 show that in a hierarchical agent society, negotiations succeed more frequently if there is status difference: the higher ranking force the transaction and take risk (high rate of high quality transactions) or force the lower ranking to do so. Egalitarian agents do not accept the risk of deceit.

In uncertainty avoiding agent societies, negotiations fail frequently if the partner is different, i.e. partners do not have common group membership. Negotiations are broken off after a few rounds, because the uncertainty avoiding agents have an urge to proceed ("time is money"). They have a strong preference for high quality commodities. They are willing to take a calculated risk to that end, but only with familiar partners. The uncertainty tolerant agents are more balanced in their judgment of transaction value and risk.

Table 2. Results of simulated negotiations for extreme settings of culture parameters, i.e. the value for the particular dimension is set to either 0.1 or 0.9, the values for the other dimensions are set to 0.5. Default values of parameters w_q, w_r, , γ, ω, β, and ι are set to 0.2, 0.1, 0.7, 0.2, 0.02, and 0.4, respectively; T: number of successful transactions; P: number of failed negotiations; P: percentage of negotions failed; R: average duration in rounds; Q: percentage of transactions with high quality

Culture type	Relation	T	F	P	R	Q
large power distance	all status high	56	38	40	3.6	24
	all status low	60	41	41	3.2	0
	higher buyers	61	33	35	3.3	25
	higher sellers	76	39	34	3.1	25
small power distance		58	56	49	3.2	2
uncertainty avoiding	different partners	39	85	69	2.6	0
	similar partners	65	46	41	2.9	22
uncertainty tolerant		48	76	61	2.9	1
individualistic		56	63	53	3.0	0
collectivistic	ingroup partners	81	23	22	3.4	14
	outgroup partners	35	77	69	3.1	0
masculine		57	55	49	3.0	18
feminine		48	43	47	3.7	10
long-term oriented		71	27	28	3.6	16
short-term oriented	general	40	72	64	3.1	13
	high partners	68	51	43	3.0	13

Individualistic agents also do not accept proposals that have too little value or too much risk. Collectivistic agents fail more frequently if they negotiate with outgroup partners. With in-group partners, they take their time to negotiate and accept the risk of deceit.

Masculine agents are impatient, break-off frequently, and go for high quality. Feminine agents try to finish the negotiations and take their time for it. Nevertheless, they do not succeed more frequently, because the step size of their concessions is too small.

Long term oriented agents show patience in their negotiations and frequently succeed, but they do not accept risk. Yet they accept high quality transactions, because they take their time to negotiate a price that covers the risk. The sort term oriented are less patient and break off more frequently, but this effect is reduced when they trade with high status partners. They accept risk if they are trading high quality products.

These results comply with the expected behavior of the agents and verify the implementation. However, they do not validate that the implemented model generates believable culturally differentiated agent behavior. For validation of the model, results of extensive simulations with realistic values of cultural parameters should be compared with empirical results from literature. A host of literature on negotiation in particular countries is available, for instance Adair et al. [21] compare negotiations in France, Russia, Japan, Hong Kong, Brazil, and the United States; Kumar and Worm [22] compare negotiations in China and India.

Table 3. Example cultures used in simulations

culture	*PDI*[*]	*UAI*[*]	*IDV*[*]	*MAS*[*]	*LTO*[*]
1	0.5	0.5	0.9	0.7	0.3
2	0.7	0.3	0.1	0.7	0.9
3	0.9	0.9	0.3	0.3	0.3
4	0.7	0.5	0.5	0.5	0.7

Table 4. Example results of a simulation run with default parameter settings as in Table 2 and cultures from Table 3

variable	supplier culture	customer culture			
		1	2	3	4
Successful transactions	1	61	45	37	69
	2	65	90	37	53
	3	49	56	59	63
	4	58	61	39	69
Percentage failed	1	49	57	69	43
	2	45	17	70	41
	3	61	47	51	41
	4	41	41	66	32
Performance [1])	1		0.00	0.08	0.05
	2	0.06		0.09	0.10
	3	0.02	-0.07		0.02
	4	0.11	0.05	0.07	

1) Performance is computed as average normalized price minus average normalized quality. A high value is an advantage for the suppliers; a low value is advantage for the customers.

The remaining part of this section presents an example of data generated by the model. An agent society of 8 suppliers and 8 customers is given time to trade and negotiate about approximately 100 transactions. All suppliers have equal cultural settings and all customers have equal settings. If agents have equal cultural settings, they are considered in-group. All agents have equal status. Table 3 displays the cultural settings. Culture 1 is modeled after North-American cultures, culture 2 is inspired by China, culture 3 by East-European cultures and culture 4 has similarity with India. Table 4 presents results of the simulations. The results in table 4 demonstrate that in the simulation model, the cultural dimension parameters have their influence. They differentiate aggregate performance in mono-cultural settings as well as in intercultural interactions. However, extensive validation is required on the basis of culture and negotiation literature and experimental data. This paper does not cover such validation. It is subject of the authors' current research.

Test Runs with Actual National Cultures

Tests have been run with agents configured with actual national cultures. For this purpose, a dataset of cultural dimensions of 62 countries was used (subset of a dataset prepared for a new edition of [2], to appear in 2010). For these cultures, the effect on ABMP parameters can be calculated, for sight validation of the parameter adaptations resulting from Table 1. The effects are presented in the Appendix (Table 6).

For all test runs, the agents were configured homogeneously with the parameter values presented in the Appendix (Table 7). All runs were replicated 10 times. The average results are presented in Table 8 in the Appendix. It should be noted that these results represent modeled behavior in a game, not in actual trade. The results show the number of successful transactions, regardless the profitability of the transactions.

The results show that the model can generate differentiation of behavior in trade for realistic cultural configurations. The effects on different observables, e.g. failure rate and average negotiation duration, are different across cultures. However, more data are required for a thorough analysis, for instance varying the group distance and status differences between agents.

Discussion and Conclusion

It is well-known that negotiation outcomes differ across the world and that people from different countries differ with respect to the way they negotiate and the results they obtain [23]. Kumar and Worm [22] relate differences in business negotiation processes with differences in economic institutions. According to Hofstede [1], the efficiency of different organizational structures and institutions depend on culture. There is ubiquitous evidence that the result of decision making in business is influenced by the cultural background of the decision makers. As a consequence, realistic business simulation models of international supply chains and networks that take the interaction between business partners into account, should incorporate culture.

Culturally differentiated behavior is not relevant in agent-to-agent negotiations, or other situations where the main purpose of application of intelligent agents is to outperform people by rational decision making, like advocated by Raiffa [11]. Culturally differentiated negotiating agents are useful in a context where human factors play a role. Social simulation is an example of such a context. [17] report a multi-agent simulation that is intended for use in combination with a gaming simulation, as a data gathering tool in supply chain research. Other application area's may be training and education, and decision support systems for human negotiations.

This paper contributes to the understanding of culture's influence on decision making in business by exploring the feasibility of Hofstede's five-dimensional

model to simulate believable agents in business. The model has been tested on imaginary cultures that differ on only one of the dimensions.

Data sets have been generated on the basis of actual national cultures. These data show relations between cultural configuration and the simulated frequency of transactions, negotiation failure ratio, duration of negotiation, quality level of traded commodities, and certification level. The results provide some face validity of the simulations, but a deeper analysis on more data is required to reveal relations in the results that can be validated.

Preliminary results of the simulation of more complex, reality-based cultures give evidence that culture in agents can be simulated by applying Hofstede's model, as was originally suggested by de Rosis et al. [24]. However, extensive validations remain for future research. A first source of validation data are the numerous papers reporting differences in negotiations across cultures, e.g. [21]. Gaming simulations like [17] could be used as a tool to collect data for more precise tuning of the model.

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Appendix

Table 5. Effects of culture on ABMP parameters based on Table 1 for a sample of 62 countries, computed for group distance 0.5, supplier status 0.3, and customer status 0.7

national culture (PDI, IDV, MAS, UAI, LTO)	Δw_q	Δw_r	$\Delta\gamma$	$\Delta\beta$	$\Delta\omega$	$\Delta\iota$
Argentina (49, 46, 56, 86, 20)	0.42	0.30	0.56	0.42	0.20	0.30
Australia (36, 90, 61, 51, 21)	0.40	0.06	0.55	0.22	0.14	0.06
Austria (11, 55, 79, 70, 60)	0.19	0.51	0.28	0.57	0.04	0.19
Bangladesh (80, 20, 55, 55, 47)	-0.01	0.18	0.40	0.10	0.32	0.08
Brazil (69, 38, 49, 76, 44)	0.25	0.37	0.39	0.25	0.28	0.25
Bulgaria (70, 30, 40, 85, 69)	0.16	0.63	0.35	0.25	0.28	0.16
Canada (39, 80, 52, 48, 36)	0.16	0.07	0.45	0.04	0.16	0.04
China (80, 20, 66, 30, 87)	-0.21	0.57	0.40	0.26	0.32	-0.21
Chile (63, 23, 28, 86, 31)	0.14	0.38	0.48	0.14	0.25	0.14
Colombia (67, 13, 64, 80, 13)	0.40	0.19	0.61	0.37	0.27	0.19
Croatia (73, 33, 40, 80, 58)	0.20	0.51	0.34	0.20	0.29	0.20
Czech Republic (57, 58, 57, 74, 70)	0.04	0.53	0.23	0.31	0.23	0.04
Denmark (18, 74, 16, 23, 35)	-0.19	-0.12	0.46	-0.61	0.07	-0.61
Estonia (40, 60, 30, 60, 82)	-0.22	0.47	0.20	-0.10	0.16	-0.22
Finland (33, 63, 26, 59, 38)	-0.12	0.16	0.43	-0.15	0.13	-0.15
France (68, 71, 43, 86, 63)	0.23	0.60	0.27	0.29	0.27	0.23
Great Britain (35, 89, 66, 35, 51)	0.15	0.32	0.34	0.32	0.14	0.15
Germany (35, 67, 66, 65, 83)	-0.17	0.54	0.17	0.32	0.14	-0.17
Greece (60, 35, 57, 112, 45)	0.55	0.62	0.39	0.57	0.24	0.55
Hong Kong (68, 25, 57, 29, 61)	-0.04	0.30	0.38	0.14	0.27	-0.04
Hungary (46, 80, 88, 82, 58)	0.30	0.59	0.29	0.76	0.18	0.30
Indonesia (78, 14, 46, 48, 62)	-0.14	0.22	0.43	-0.06	0.31	-0.14
India (77, 48, 56, 40, 51)	0.02	0.22	0.34	0.12	0.31	0.05
Iran (58, 41, 43, 59, 14)	0.29	-0.01	0.60	0.02	0.23	-0.01
Ireland (28, 70, 68, 35, 24)	0.44	0.15	0.53	0.36	0.11	0.15
Israel (13, 54, 47, 81, 38)	0.28	0.38	0.43	0.28	0.05	0.28
Italy (50, 76, 70, 75, 61)	0.14	0.48	0.27	0.45	0.20	0.14
Japan (54, 46, 95, 92, 88)	0.07	0.87	0.27	0.68	0.22	0.07
Korea South (60, 18, 39, 85, 100)	-0.15	0.85	0.41	0.24	0.24	-0.15
Latvia (44, 70, 9, 63, 69)	-0.28	0.41	0.22	-0.28	0.18	-0.28
Lithuania (42, 60, 19, 65, 82)	-0.17	0.52	0.20	-0.16	0.17	-0.17
Luxembourg (40, 60, 50, 70, 64)	0.06	0.45	0.25	0.20	0.16	0.06
Malaysia (104, 26, 50, 36, 41)	-0.11	0.09	0.41	0.00	0.40	0.00
Mexico (81, 30, 69, 82, 24)	0.25	0.29	0.53	0.47	0.32	0.29
Malta (56, 59, 47, 96, 47)	0.43	0.59	0.37	0.43	0.22	0.43
Morocco (70, 46, 53, 68, 14)	0.37	0.08	0.60	0.21	0.28	0.08
Netherlands (38, 80, 14, 53, 67)	-0.33	0.30	0.23	-0.33	0.15	-0.33
Norway (31, 69, 8, 50, 35)	-0.27	0.05	0.46	-0.42	0.12	-0.42
New Zealand (22, 79, 58, 49, 33)	0.25	0.11	0.47	0.16	0.09	0.11
Pakistan (55, 14, 50, 70, 50)	0.20	0.35	0.43	0.20	0.22	0.20
Peru (64, 16, 42, 87, 25)	0.29	0.35	0.53	0.29	0.26	0.29
Philippines (94, 32, 64, 44, 27)	0.07	0.13	0.51	0.28	0.38	0.13
Poland (68, 60, 64, 93, 38)	0.45	0.50	0.43	0.57	0.27	0.50
Portugal (63, 27, 31, 104, 28)	0.31	0.50	0.50	0.31	0.25	0.31
Romania (90, 30, 42, 90, 52)	0.27	0.56	0.36	0.32	0.36	0.32
Russia (93, 39, 36, 95, 81)	0.14	0.82	0.37	0.31	0.37	0.14
South Africa (49, 65, 83, 49, 34)	0.49	0.37	0.46	0.66	0.20	0.37
El Salvador (66, 19, 40, 94, 20)	0.34	0.38	0.56	0.34	0.26	0.34
Serbia (86, 25, 43, 92, 52)	0.32	0.58	0.38	0.35	0.34	0.35

Singapore (74, 20, 48, 8, 72)	-0.24	0.28	0.40	-0.04	0.30	-0.24
Slovak Republic (104, 52, 110, 51, 77)	0.23	0.84	0.40	0.76	0.40	0.23
Slovenia (71, 27, 19, 88, 49)	0.07	0.52	0.37	0.07	0.28	0.07
Spain (57, 51, 42, 86, 48)	0.28	0.50	0.36	0.28	0.23	0.28
Sweden (31, 71, 5, 29, 53)	-0.48	0.05	0.33	-0.66	0.12	-0.66
Taiwan (58, 17, 45, 69, 93)	-0.24	0.64	0.42	0.14	0.23	-0.24
Thailand (64, 20, 34, 64, 32)	0.02	0.16	0.48	-0.02	0.26	-0.02
Trinidad and Tobago (47, 16, 58, 55, 13)	0.45	-0.03	0.61	0.16	0.19	-0.03
Turkey (66, 37, 45, 85, 46)	0.30	0.47	0.38	0.30	0.26	0.30
Uruguay (61, 36, 38, 100, 26)	0.38	0.48	0.52	0.38	0.24	0.38
U.S.A. (40, 91, 62, 46, 26)	0.36	0.10	0.52	0.24	0.16	0.10
Venezuela (81, 12, 73, 76, 16)	0.27	0.17	0.59	0.32	0.32	0.17
Vietnam (70, 20, 40, 30, 57)	-0.17	0.10	0.40	-0.20	0.28	-0.20

Table 6. Default and maximal and minimal values used for cultural adaptations in Table 7

	w_q	w_r	γ	β	ω	ι
default x_T	0.05	0.05	0.6	0.3	0.02	0.3
maximum x_H	0.2	0.2	1	0.5	0.1	0
minimum x_L	0	0	n.a.	0	n.a.	1

[the increase of ω depends on round number ρ : $\Delta\omega = PDI^{*}(s_p - s_a)\rho$];
[the effect of ι=1 is that the probability of quitting a negotiation in case of insufficient progress or unrealistic bidding equals 0.5: $P(\text{quit}) = 0.5\iota$]

Table 7. Average results of 10 simulation runs with 8 supplier agents and 8 buyer agents, with group distance 0.5, supplier status 0.3 and customer status 0.7; T: number of successful transactions; P: number of failed negotiations; P: percentage of negotions failed; R: average duration in rounds; Q: percentage of transactions with high quality; C: percentage of certified transactions

national culture (PDI, IDV, MAS, UAI, LTO)	T	F	P	R	Q	C
Argentina (49, 46, 56, 86, 20)	56	36	39	3.1	34	7
Australia (36, 90, 61, 51, 21)	70	25	26	4.3	30	5
Austria (11, 55, 79, 70, 60)	60	41	41	4.0	25	4
Bangladesh (80, 20, 55, 55, 47)	68	38	36	3.6	26	5
Brazil (69, 38, 49, 76, 44)	65	26	29	3.8	34	5
Bulgaria (70, 30, 40, 85, 69)	56	33	37	3.3	37	3
Canada (39, 80, 52, 48, 36)	62	33	35	3.8	34	8
China (80, 20, 66, 30, 87)	87	15	15	4.2	20	2
Chile (63, 23, 28, 86, 31)	75	18	19	4.1	39	7
Colombia (67, 13, 64, 80, 13)	83	30	27	3.4	46	7
Croatia (73, 33, 40, 80, 58)	58	37	39	3.5	28	5
Czech Republic (57, 58, 57, 74, 70)	60	27	31	4.2	23	4
Denmark (18, 74, 16, 23, 35)	58	14	19	5.3	7	1
Estonia (40, 60, 30, 60, 82)	71	20	22	4.7	11	2
Finland (33, 63, 26, 59, 38)	69	16	19	4.5	23	5
France (68, 71, 43, 86, 63)	63	35	36	3.2	21	0
Great Britain (35, 89, 66, 35, 51)	70	51	42	4.0	27	0
Germany (35, 67, 66, 65, 83)	73	26	26	4.3	19	1
Greece (60, 35, 57, 112, 45)	54	38	41	3.0	41	9
Hong Kong (68, 25, 57, 29, 61)	68	31	31	3.8	24	3
Hungary (46, 80, 88, 82, 58)	62	27	30	3.6	23	5
Indonesia (78, 14, 46, 48, 62)	77	25	25	4.4	27	6

India (77, 48, 56, 40, 51)	63	26	29	3.5	32	9
Iran (58, 41, 43, 59, 14)	71	22	24	4.0	42	7
Ireland (28, 70, 68, 35, 24)	67	30	31	4.4	31	5
Israel (13, 54, 47, 81, 38)	52	38	42	3.2	27	5
Italy (50, 76, 70, 75, 61)	53	34	39	3.7	26	6
Japan (54, 46, 95, 92, 88)	67	36	35	3.8	15	2
Korea South (60, 18, 39, 85, 100)	79	16	17	4.2	20	2
Latvia (44, 70, 9, 63, 69)	56	33	37	4.2	12	0
Lithuania (42, 60, 19, 65, 82)	64	31	33	4.5	19	1
Luxembourg (40, 60, 50, 70, 64)	67	30	31	4.0	18	2
Malaysia (104, 26, 50, 36, 41)	60	41	41	3.6	32	2
Mexico (81, 30, 69, 82, 24)	55	45	45	3.1	47	11
Malta (56, 59, 47, 96, 47)	59	35	37	3.2	24	2
Morocco (70, 46, 53, 68, 14)	65	20	24	3.6	35	2
Netherlands (38, 80, 14, 53, 67)	46	31	40	5.2	17	0
Norway (31, 69, 8, 50, 35)	66	24	27	5.3	15	4
New Zealand (22, 79, 58, 49, 33)	66	40	38	4.2	21	4
Pakistan (55, 14, 50, 70, 50)	72	17	19	4.1	29	6
Peru (64, 16, 42, 87, 25)	79	24	23	3.5	32	2
Philippines (94, 32, 64, 44, 27)	69	31	31	3.8	42	12
Poland (68, 60, 64, 93, 38)	41	45	52	2.5	54	19
Portugal (63, 27, 31, 104, 28)	63	31	33	3.4	33	5
Romania (90, 30, 42, 90, 52)	68	26	28	3.4	37	7
Russia (93, 39, 36, 95, 81)	70	27	28	3.3	29	6
South Africa (49, 65, 83, 49, 34)	67	37	36	3.8	36	7
El Salvador (66, 19, 40, 94, 20)	69	35	34	3.7	36	4
Serbia (86, 25, 43, 92, 52)	56	43	43	3.3	52	5
Singapore (74, 20, 48, 8, 72)	75	17	18	4.2	20	5
Slovak Republic (104, 52, 110, 51, 77)	75	17	18	3.5	24	4
Slovenia (71, 27, 19, 88, 49)	71	33	32	4.2	32	4
Spain (57, 51, 42, 86, 48)	61	22	27	4.0	26	1
Sweden (31, 71, 5, 29, 53)	51	10	16	7.3	4	1
Taiwan (58, 17, 45, 69, 93)	82	10	11	4.2	28	4
Thailand (64, 20, 34, 64, 32)	66	38	37	3.5	35	4
Trinidad and Tobago (47, 16, 58, 55, 13)	80	16	17	4.0	42	10
Turkey (66, 37, 45, 85, 46)	58	25	30	3.7	38	9
Uruguay (61, 36, 38, 100, 26)	50	33	40	3.1	26	9
U.S.A. (40, 91, 62, 46, 26)	72	27	27	4.4	40	4
Venezuela (81, 12, 73, 76, 16)	75	24	24	3.6	39	5
Vietnam (70, 20, 40, 30, 57)	69	22	24	4.4	22	8