A Multi-agent Model of Deceit and Trust in Intercultural Trade

3 authors, including:

Gert Jan Hofstede
Wageningen University & Research
210 PUBLICATIONS   **7,592** CITATIONS

SEE PROFILE

Catholijn M. Jonker
Delft University of Technology
542 PUBLICATIONS   **6,325** CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Project   COREDEMA 2017 - 3rd International Workshop on Conflict Resolution in Decision Making In conjunction with the International Joint Conference on Artificial Intelligence (IJCAI-2017) View project

Project   Pocket Negotiator, synergy between man and machine View project

A Multi-agent Model of Deceit and Trust in Intercultural Trade

Gert Jan Hofstede[1,2], Catholijn M. Jonker[2], and Tim Verwaart[3]

[1] Wageningen University, Postbus 9109, 6700 HB Wageningen, The Netherlands
gertjan.hofstede@wur.nl
[2] Delft University of Technology, Mekelweg 4, 2628 CD Delft, The Netherlands
c.m.jonker@tudelft.nl
[3] LEI Wageningen UR, Postbus 29703, 2502 LS Den Haag, The Netherlands
tim.verwaart@wur.nl

Abstract. Trust is a sine qua non for trade. According to transaction cost economics, a contract always offers some opportunity to defect. In the case of asymmetric product information, where the seller is better informed about product quality than the buyer is, the buyer either has to rely on information provided by the seller or has to check the information by testing the product or tracing the supply chain processes, thus incurring extra transaction cost. An opportunistic seller who assumes the buyer to trust, may deliver a lower quality product than agreed upon. In human decisions to deceive and to show trust or distrust toward business partners, issues like morality, shame, self-esteem, and reputation are involved. These factors depend strongly on trader's cultural background. This paper develops an agent model of deceit and trust and describes a multi-agent simulation where trading agents are differentiated according to Hofstede's dimensions of national culture.

Keywords: trust and reputation management, deceit, negotiation, trade partner selection, culture.

1 Introduction

A business transaction usually incurs cost on transaction partners, thus reducing the value of the transaction for the party bearing the cost. In transaction cost economics [1] opportunism and the incompleteness of contracts are central issues. Due to bounded rationality, contracts cannot specify solutions for all contingencies that may occur in transactions executed under the contracts. The incompleteness offers contract partners opportunities to defect. As Williamson [1] asserts, not every contract partner will take full advantage of every opportunity to defect. However, it is the uncertainty about a contract partner's opportunism that incurs transaction cost. *Ex ante* and *ex post* types of transaction cost can be distinguished. *Ex ante* are the cost of searching, bargaining, drafting, and safeguarding of contracts. *Ex post* are the cost of monitoring and enforcing task completion. Transaction cost economics is the basis for the process model of trading agents applied in this paper. The process model is depicted in Fig. 1.
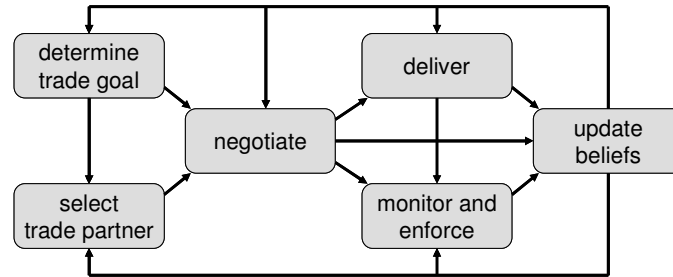
Fig. 1. Processes and internal information flows of trading agents.

The outcome of successful negotiation is a contract. After that, it comes to delivery. An agent may deliver according to contract, or fail to do so intentionally (opportunism) or unintentionally (by incompetence or a flaw of its quality control system). At the same time, an agent may monitor the other party's delivery and either check if it is according to contract, or trust and accept without checking. Klein Woolthuis et al. [2] studied the relationship between trust and contracts. They concluded that trust can substitute or complement contracts: if trust is high, contracts can either be rather incomplete, because parties do not expect deceit, or more complete but not actively monitored and enforced, as a signal confirming the trusting relationship; if trust is low, a contract can either be rather complete as a safeguard against opportunism, or incomplete because of opportunistic intentions (so, contract incompleteness does not necessarily imply trust).

The trading situation of the simulation presented in this paper is based on the Trust And Tracing game [3]. In this game, players select trade partners and trade imaginary food products that have a value-increasing quality attribute known by the supplier, but invisible to the customer, e.g. "organically grown". The customer can, at the cost of a fee, involve the Tracing Agency to test the actual quality. The Tracing Agency reports the test's outcome to both customer and supplier, and in case of untruthful delivery, punishes the supplier by a fine. Based on experience from negotiation and tracing results, agents update their beliefs about the market, potential partners, and the risks of opportunistic behavior. This paper focuses on the post-contract phase. The models for trust, deceit, and experience-based belief update are described in Section 2.

Human decisions to deceive and to trust are not strictly rational; they are influenced by emotions [4]. As such, they are known to depend on cultural background [5], [6]. G. Hofstede's five dimensions of national cultures [7] are widely used to identify cultural differences. G.J. Hofstede et al. described models for the influence of culture on trade processes, including deceit and trust, for each of the five dimensions separately [8], [9], [10], [11], [12]. However, the differentiation of human behavior cannot be described along a single one of these dimensions. The present paper's goal is to integrate G.J. Hofstede et al.'s individual dimension models, focusing on the decisions whether to deliver truthfully or untruthfully (*deceit*) and whether to trace the delivery or to accept it without tracing (*trust*), and on experience-based belief update about partner's trustworthiness and benevolence (i.e. its inclination to trust). Section 3 presents the model of the influence of culture on deceit and trust. Section 4 describes experimental results from multi-agent simulations. Section 5 concludes the paper with a discussion of the results.

2 Modeling Deceit, Trust, and Experience-Based Belief

The simulation model represents the trade process of The Trust And Tracing game [3], where a group of 15-20 participants repeatedly trade commodities of different quality levels for an a priori unknown time. Suppliers are informed about the quality; customers are not informed. Participants are free to select a partner for each transaction, and negotiate about price, quality to be delivered, and conditions of the contract. Customers may (a) avoid deceit by buying low quality or (b) buy high quality and either (b1) accept vulnerability and trust the supplier to deliver according to contract, or (b2) protect themselves by negotiating a guarantee, for instance money back in case deceit would be revealed, or (b3) have the commodity traced in advance (certification). Option (a) is free of cost and risk, and a low price may be negotiated, but the customer has to accept low quality. Options (b1) and (b2) incur risk on the customer (as they offer the seller an opportunity to defect), and additional cost only if the customer decides to monitor (trace) the delivery. The certification option (b3) excludes risk, but always incurs additional cost.

Although trust is also relevant for the processes of partner selection and negotiation, the present paper focuses on the post-contract phase of transactions. It describes the decision whether to deceive or not in the delivery process, the decision whether to trust or to trace in the monitoring and enforcing process, and the update of beliefs resulting from confirmed or violated trust. The remaining part of this section discusses relevant literature from the social sciences and introduces the agent's decision models applied in the simulation.

In experiments using a repetitive ultimatum game with asymmetric information, Boles et al. [4] found that most people do not choose deceptive strategies. However, deceit occurred in their experiments, in particular when stakes were high. So, for deceit to occur, at least two conditions have to be satisfied: motive (substantial advantage for the deceiver) and opportunity (lack of information on the part of the deceived).

As Boles et al. found, the conditions of motive and opportunity are not sufficient for deceit. The decision to deceive depended on interpersonal interactions and the player's satisfaction about the behavior of the other party. They report that "*the bargainers were little like those depicted by rational economic models*" [4] and that "*responders may react emotionally and reject profitable offers in the present when they realize that they have been deceived in the past*" [4].

Role-playing research into cheating on service guarantees by consumers reported by Wirtz and Kum [13] confirms that people are not inclined to seize any opportunity to cheat. Their research also confirms that potential material gain is a condition for cheating, but they found no evidence that people who cheat let their decision depend on the expected amount of payout or the ease of the opportunity to cheat. They report cheating to be related to personality of players (morality, Machiavellianism and self-monitoring). Two factors found to decrease cheating were satisfaction about the deal and the expectation of repeated dealing with the supplier in the future. Wirtz and Kum [13] suggest that a sense of loyalty and trust may reduce cheating. They also refer to Hwang and Burgers [14] that take an economics approach and argue that the high cost of the loss of a trusted partner is an inhibitor of opportunism. Both views indicate that a high-trust relation inhibits deceit.

In the research discussed above, four factors that influence deceit are found: opportunity, expected payout, player's personal traits and values, and player's trust relationship with their counterpart. Steinel and De Dreu [15] conclude on the basis of experiments with the Information Provision Game that, due to greed and maybe to fear of exploitation, individuals are less honest when they experience their counterpart to be competitive rather than cooperative, and that this tendency is stronger for prosocial than for selfish individuals. The importance of the relationship and the behavior of the counterpart is confirmed by Olekalns and Smith [16] who contrast two models of ethical decision making: *fair trade* (my counterpart trusts me, so I will cooperate) and *opportunistic betrayal* (my counterpart trusts me, so I can easily defect). In experiments with Australian undergraduate students they found strong support for *fair trade* as the prevailing model. However, Wirtz and Kum [13] found that individuals scoring high on Machiavellianism in the personality test, were more easily tempted to seize an opportunity to cheat and actually followed what Olekalns and Smith [16] called the *opportunistic betrayal* model.

A general conclusion of the work cited so far in this section is that deceit is less likely to occur when trade partners show trust in each other, even when rational strategies to win the game would suggest cheating. As the purpose of the multi-agent simulation reported in this paper is to represent actual human behavior rather than to apply deception as a strategy to win a game, we cannot employ rational models like the ones proposed by Castelfranchi et al. [17] and Ward and Hexmoor [18].

In the simulation an agent's decision to deceive is modeled as a Bernoulli variable with probability of deceit

$$p(\text{deceit}) = q \,(1 - c) \, m_i \, (1 - d_i) \,, \tag{1}$$

where q represents the quality agreed in the current contract ($q=1$ for high quality; $q=0$ for low quality or no opportunity); $c=1$ if certification has been agreed (no opportunity); $c=0$ otherwise; m_i represents the supplier's motive or rationale to deceive customer i ($m_i = 1$ if the supplier expects an extra profit from deceit; $m_i=0$ otherwise, for instance if the customer negotiated a guarantee and the supplier expects the customer to trace the delivery); d_i represents on the interval [0, 1] seller's threshold for deceit toward customer i, where $d_i=1$ represents perfect truthfulness. d_i is influenced by seller's personal traits and values (like risk aversion and morality), power and group relations, and seller's estimate of customer's benevolence toward the seller, i.e., seller's trust that the customer will accept deliveries without tracing. Details on d_i and the influence of cultural background are discussed in Section 3.

For the purpose of the simulation, Klein Woolthuis et al.'s [2] narrow definition of trust is adopted. A customer's trust in a particular supplier is defined as the customer's estimate of the probability that the supplier will cooperate and deliver according to contract, even if the supplier has the motive and the opportunity to defect. However, this does not imply that an agent's decision to have a delivery traced can be modeled as a Bernoulli variable with $p(\text{trace})=q(1-c)(1-t_j)$ where $q(1-c)$ represent opportunity as in equation (1) and t_j represents trust in supplier j. Additional factors like power and group relationships with the supplier and the agent's cultural background also have their effect on the decision to trace. The effects of relationships and cultural background on the tracing decision are discussed in Section 3.

Trust and distrust develop during social interactions. Visual and auditory contact is relevant to develop trust and detect deceit in human interactions [19]. However, the multi-agent simulation does not support these effects. The only sources of information that can be taken into account are negotiation outcomes and tracing reports, which are relevant in reality as well. Every successful negotiation, resulting in a transaction will strengthen partners' trust in each other. However, customers can decide to trace a delivery and this can have its effects on mutual trust. First, if the result of tracing reveals deceit, the customer's trust in the seller will be reduced. Second, to some extent the fine and the reputational damage resulting from revealed deceit will reinforce the supplier's honesty. However, reinforced honesty will decay to its original level in the course of time. Third, the supplier delivering truthfully may be offended by tracing and the relation may be damaged. For this reason, customers may exercise restraint to trace. Tracing will always reduce the supplier's belief about customer's benevolence. So, the following dynamics have to be modeled:

- development of trust and benevolence belief by successful negotiations;
- for customers: reduction of trust in case of revealed deceit;
- for suppliers: reinforcement of honesty in case of revealed deceit;
- for suppliers: decay of reinforced honesty to a base level;
- for suppliers: reduction of benevolence belief in case of tracing.

Formal models for representing the development of trust were analyzed by Jonker and Treur [20]. They distinguish six types of trust dynamics: blindly positive, blindly negative, slow positive – fast negative, balanced slow, balanced fast, and slow negative – fast positive. The most realistic type of dynamics for trust in trading situations is slow positive – fast negative: it takes a series of positive experiences to develop trust, but trust can be destroyed by a single betrayal (e.g., Boles et al. [4] report that deceit leads to emotional reactions and consequences beyond what is rational; Steinel and De Dreu [15] refer to "*punitive sentiment*" towards deceivers). A consumer's trust in supplier j after the n'th experience is updated as follows.

$$
\begin{array}{ll}
t_{j,n} = t_{j,n-1} + u^{+}(1- t_{j,n-1}) & \text{if } n^{\text{th}} \text{ experience is positive ,} \\
t_{j,n} = (1-u^{-})\, t_{j,n-1} & \text{if } n^{\text{th}} \text{ experience is negative ,} \\
t_{j,n} = t_{j,n-1} & \text{if } n^{\text{th}} \text{ experience is neither positive nor negative ,}
\end{array}
\tag{2}
$$

with $0 < u^{+} < u^{-} < 1$, where $t_{j,n} = 1$ represents complete trust and $t_{j,n} = 0$ represents complete distrust; a successful negotiation counts as a positive experience; a tracing report revealing deceit counts as negative; all other experiences are considered neither negative nor positive with respect to trust.

A supplier's belief $b_{i,n}$ about customer i's benevolence is updated by the same mechanism. Also for the supplier, a successful negotiation counts as a positive experience. However, tracing always counts as a negative experience for a supplier, whether it reveals deceit or not, because it is interpreted as distrust.

An effect of revealed deceit on the supplier's part is that supplier's current honesty h_k (a personal trait, representing the inclination to deliver truthfully) is reinforced to 1, representing maximal honesty. h_k will subsequently decay to a base value h' on each interaction, whether it is successful or not, with a decay factor f.

$$
h_k = h' + f\,(h_{k-1}- h') , \text{ with } 0 < h' < 1 \text{ and } 0 < f < 1 .
\tag{3}
$$

3 The Influence of Culture on Deceit and Trust

The preceding section introduced models for deceit, trust and belief update in a process of trade. The roles of deceit and trust are known to be different across cultures [5], [6]. Therefore, a multi-agent simulation of international trade that models the effects of deceit and trust should include the effects of culture. This section proposes an approach to model the effects of culture on the parameters and variables introduced in the previous section (deceit threshold, inclination to trace, and positive and negative trust update factors), based on G. Hofstede's dimensions of culture [7]. First culture and Hofstede's dimensions and their effects on deceit and tracing are discussed; than the agent's decision models are proposed.

Hofstede describes culture as "*the collective programming of the mind that distinguishes the members of one group or category of people from another*" [7], p. 9. This implies that culture is not an attribute of individual people, unlike personality characteristics. It is an attribute of a group that manifests itself through the behaviors of its members. For a trading situation, culture of the trader will manifest itself in four ways. First, culture filters observation. It determines the salience of clues about the acceptability of trade partners and their proposals. Second, culture sets norms for what constitutes an appropriate partner or offer. Third, it sets expectations for the context of the transactions, e.g., the enforceability of regulations and the possible sanctions in case of breach of the rules. Fourth, it sets norms for the kind of action that is appropriate given the other three and, in particular, the difference between the actual situation and the desired situation.

Table 1. Hofstede's dimensions of culture [7]

Dimension	Definition
Power Distance	"*The extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally*" [7], p. 98
Uncertainty Avoidance	"*The extent to which the members of a culture feel threatened by uncertain or unknown situations*" [7], p. 161
Individualism and Collectivism	"*Individualism stands for a society in which the ties between individuals are loose: Everyone is expected to look after him/herself and her/his immediate family only. Collectivism stands for a society in which people from birth onward are integrated into strong, cohesive in-groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty*" [7], p. 255
Masculinity and Femininity	"*Masculinity stands for a society in which social gender roles are clearly distinct: Men are assumed to be assertive, tough, and focused on material success; women are supposed to be more modest, tender and concerned with the quality of life. Femininity stands for a society in which gender roles overlap: Both men and women are supposed to be modest, tender and concerned with the quality of life.*" [7], p. 297
Long- Versus Short-Term Orientation	"*Long Term Orientation stands for the fostering of virtues oriented towards future rewards, in particular, perseverance and thrift. Its opposite pole, Short Term Orientation, stands for the fostering of virtues related to the past and the present, in particular, respect for tradition, preservation of 'face' and fulfilling social obligations*" [7], p. 359

G. Hofstede [7] identified five dimensions to compare national cultures (Table 1). For the dimensions, indices are available for many countries in the world. The indices are usually named as PDI, UAI, IDV, MAS, and LTO. For the multi-agent model, we scale the indices to the interval [0, 1] and refer to the scaled indices as PDI^*, UAI^*, IDV^*, MAS^*, and LTO^*. E.g., IDV^* refers to the degree of individualism and $1\text{-}IDV^*$ to the degree of collectivism, both in the range [0, 1].

G.J. Hofstede et al. [8], [9], [10], [11], [12], modeled the influence on trade processes of each of the five dimensions separately. However, single dimensions do not fully represent the differentiation of human behavior. A realistic simulation must take the simultaneous effect of all dimensions into account. The purpose of the present paper is to develop a first version of integrated models for deceit, trust and belief update. The remaining part of this section summarizes the effects of individual dimensions as described in [8], [9], [10], [11], [12], and then proposes the integration of the formal specifications reported in those papers.

Power Distance. [8] On the dimension of power distance, egalitarian societies are on the one extreme (small power distance), hierarchical societies on the other (large power distance). In hierarchical societies, status and position in the societal hierarchy are the main issue in relations. Trust is only relevant among partners that have equal status. 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. With respect to deceit, the higher ranked do not have to fear for repercussions when trading with lower ranked, so the decision, whether to defect or not, merely depends on their morality. The lower ranked on the other hand will not easily consider to defect and will usually cooperate when trading with higher ranked and will only defect if in need.

For egalitarian traders, decisions to deceive and to trust are not influenced by status difference. Trust is equally important in every relation, regardless of partner's status. However, showing distrust may be harmful to relations, so there may be other incentives for benevolent behavior.

Uncertainty Avoidance. [9] Uncertainty avoidance must not be confused with risk avoidance. People in uncertainty avoiding societies accept risks they are familiar with, but they fear the unknown. They are willing to take risks in order to reduce uncertainty about things they are not familiar with, or to eliminate them.

Uncertainty avoiding traders fear and distrust strangers. They follow the rules when dealing with familiar relations, but easily deceive strangers. A foreign partner will be distrusted until sufficient evidence for the contrary has been found. Once, in the course of repeated transactions, sufficient evidence for trustworthiness has been found through tracing of deliveries, and partners have become familiar, the uncertainty avoiding may finally come to trust their partners and expect them to follow the rules like they do themselves. After they have come to trust, any unexpected revelation of deceit provokes furious reactions from uncertainty avoiding traders. They will not easily deal again with a partner that abused their trust.

Individualism and Collectivism. [10] In individualistic societies, people have a personal identity and are responsible for their personal actions and view a business partner as an individual. In collectivistic societies, a person's identity is primarily given by group memberships (such as extended family, village, and clubs) and relations. People from collectivistic societies feel responsible for their in-group and prefer to trade with their in-group. Serious negotiations with out-group business partners must be preceded by some form of familiarization. In collectivistic societies harmony must be preserved, so the threshold for showing distrust by tracing is high.

In collectivistic societies trust and deceit are based on group memberships and norms. People from collectivistic societies primarily trust in-group members and distrust out-group members. After a long-lasting relation, outsiders may be trusted as in-group members. Deceiving an out-group partner is acceptable if it serves in-group interests. In individualistic societies opportunistic behavior and trust are based on personal interests, personal values, and interpersonal relations.

Masculinity and Femininity. [11] On the masculine extreme of the dimension are competitive, performance-oriented societies; on the other are cooperation-oriented societies. A cooperation-oriented trader is interested in the relationship. Building trust is important. In principle, the cooperation-oriented trader does not trace, since in his mind this would constitute ostentation of distrust. If conned, then the cooperation-oriented trader will avoid the conman if possible, or give him one more chance.

Trust is irrelevant in extremely performance-oriented societies. A performance-oriented trader sticks to the contract of the deal, and deceives the trade partner to the limits of the contract without any compunction. As a consequence, the performance-oriented trader sees no problems in dealing again with a trader that conned him in the past: "It's all in the game". The performance-oriented trader always traces the goods after buying, since he expects the possibility of deception. The trader learns from mistakes to make sure that new contracts will not lead to new and uncomfortable surprises on his side.

Long- Versus Short-Term Orientation. [12] Traders from long-term oriented societies value their relations. They value a deal not only by the financial pay off, but also by the relational gains. They are inclined to invest in relations by behaving truthfully and by trusting their partners. They value their business relations by the prospect of future business. They have no respect for others that put their relations at stake for some short-term profit. If they turn out to be deceived by a business partner they will not easily forgive the deceiver.

People from short-term oriented cultures find it hard to understand the sacrifice of the long-term oriented. The short-term oriented tend to grab a chance for an easy profit and are willing to put their relations at stake for it, especially if they are in need to fulfil other social obligations, like showing off for family members. They calculate the bottom line of the transaction. Their threshold to deceive or to distrust depends on the value they attach to the relation in their social life. They can understand that a business partner may be tempted to defect if a profitable opportunity occurs, and they have trouble understanding that people from long-term oriented cultures cannot.

Table 2. Influence of Hofstede's dimensions of culture and partner characteristics on deceit and trust (+ indicates increasing influence; - indicates decreasing influence; 0 indicates no effect).

Culture and partner characteristics	Effect on deceit threshold	Effect on inclination to trace	Effect on positive upd. factor	Effect on negative upd. factor
Large power distance				
- with lower ranked partner	0	-	0	0
- with higher ranked p.	+	-	0	0
Small power distance	0	0	0	0
Uncertainty avoiding				
- with familiar partner	0	0	-	+
- with stranger	-	+	-	+
Uncertainty tolerant	0	0	0	0
Individualistic	0	0	0	0
Collectivistic				
- with in-group partner	0	-	0	+
- with out-group partner	-	0	0	+
Masculine (competitive)	-	+	0	-
Feminine (cooperative)	0	-	0	0
Long-term oriented	+	-	0	+
Short-term oriented				
- with respected partner	+	-	0	0
- with other partners	-	0	0	0

[8], [9], [10], [11], [12] proposed formal models for the influence of individual culture dimensions on trade processes, including effects on deceit threshold, inclination to trace, and positive and negative trust update factors. Table 2 summarizes these effects.

In the multi-agent simulation the decision to deceive is modeled as a random one, with probability of deceit as in equation (1), and p(truthful delivery)=1-p(deceit). Quality q and certification c are attributes of the contract. If either $q=0$ or $c=1$, there is no opportunity to deceive, so the agent delivers truthfully. If the customer negotiated a guarantee, and the agent is convinced that the partner will trace rather than trust the delivery there is no motive to deceive. The motive depends on value difference between high and low quality Δv, customer's benevolence b_j, fine r, and value v to be restituted in case of a guarantee; $g=1$ indicates guarantee, $g=0$ no guarantee):

$$m_i = 1 \ \text{ if } \ \Delta v > (1-b_i)\{r+gv\} \ ; \ \text{ otherwise } \ m_i = 0 . \tag{4}$$

If motive and opportunity are present, the decision is effected by the agent's current honesty h and its belief about the relation with the customer b_i. We assume that the deceit threshold toward agent i has max(h, b_i) as a basis, which is modified by cultural effect e^d_i in the direction of 1 if $e^d_i > 0$; in the direction of 0 if $e^d_i < 0$:

$$d_i = \max(h, b_i) + \{1-\max(h, b_i)\} \ (|e^d_i|+e^d_i)/2 - \max(h, b_i)(\ |e^d_i|-e^d_i)/2 \ , \tag{5}$$

To model the effect of culture, for both negative and positive modification of the deceit threshold, the index with the maximal effect is selected:

$$e^d_i = \max\{\text{PDI}^*(s_i\text{-}s_j), \text{LTO}^*, (1\text{-}\text{LTO}^*)s_i\}$$
$$- \max\{\text{UAI}^*D_{ij}, (1\text{-}\text{IDV}^*)D_{ij}, \text{MAS}^*, (1\text{-}\text{LTO}^*)(1\text{-}s_i)\} . \tag{6}$$

where s_i indicates partner's status or hierarchical position in society and s_j indicates own societal status, both on the interval [0, 1]; D_{ij} represents group distance, i.e. D_{ij}=0 represents maximal familiarity; a complete stranger has D_{ij}=1.

Similarly, the decision to trace or to trust is modeled, with distrust $(1 - t_j)$ as the basis for the decision, with cultural effect e^t_j on the inclination to trace j's deliveries.

$$p(\text{trace}) = q\,(1\text{-}c)\,\{1 - t_j - t_j\,(|e^t_j| + e^t_j)/2 - (1\text{-}t_j)\,(|e^t_j| - e^t_j)/2\}\,;$$
$$p(\text{trust}) = 1 - p(\text{trace}) . \tag{7}$$

$$e^t_j = \max(\text{UAI}^*D_{ij}, \text{MAS}^*)$$
$$- \max\{\text{PDI}^*|s_i\text{-}s_j|, (1\text{-}\text{IDV}^*)(1\text{-}D_{ij}), 1\text{-}\text{MAS}^*, \text{LTO}^*, (1\text{-}\text{LTO}^*)s_j\} . \tag{8}$$

The basic values $u^{+'}$ and $u^{-'}$ of the update factors are modified in a similar way.

$$u^+ = u^{+'} - u^{+'}\text{UAI}^* . \tag{9}$$

$$u^- = u^{-'} + (1 - u^{-'})(|e^{u\text{-}}| + e^{u\text{-}})/2 - (u^{-'} - u^{+'})(|e^{u\text{-}}| - e^{u\text{-}})/2 ; \tag{10}$$

$$e^{u\text{-}} = \max\{\text{UAI}^*, (1\text{-}\text{IDV}^*), \text{LTO}^*\} - \text{MAS}^* . \tag{11}$$

4 Example of Results

To test the implementation of the model, simulations were run in an environment where agents could trade repeatedly, approximately 30-40 times per run. For all deals, q=1 or c=0, forcing the agents to decide on deceit and trust. In all runs, the culture dimensions were set to 0.5, except one dimension, which was set to 0.1 or 0.9 in order to represent a cultural extreme. Agents had labels, visible to all other agents. One represented status (societal rank). Other labels represented group memberships. Taking trust and benevolence developed by rule (2) as a proxy for familiarity, D_{ij} was computed as the minimum of label-based and familiarity-based group distance.

The results presented in Table 3 indicate that culturally differentiated agent behavior at the micro level has impact on macro level statistics. The tendencies are as expected. The tracing rate is high in uncertainty avoiding and masculine societies, indicating low trust. The tracing is effective to reduce cheating. In short-term oriented societies opportunity is given to high-status members. They are not traced and seize the opportunity. In feminine societies honesty is not enforced but the deceit frequency remains low because of the strong inclination to cooperate in these societies.

Table 3. Results of simulations in societies with hypothetical cultures. In the hypothetical cultures all scaled cultural dimensions have index 0.5, except one, which has either 0.1 or 0.9.

Culture and partner characteristics	Percent of transactions traced	Percentage of deceit in traces	Percent of deceit in all transactions	Percentage of deceit discovered
Large power dis., mixed ranks	11	7	13	6
Small power distance	11	12	11	12
Uncertainty avoiding, ingroup	59	9	7	77
Uncertainty tolerant	9	21	7	26
Individualistic	12	7	8	10
Collectivistic, ingroup partner	14	27	14	26
Masculine (competitive)	56	14	13	62
Feminine (cooperative)	1	33	13	3
Long-term oriented	6	6	9	4
Short-t. oriented, mixed ranks	15	31	25	19

5   Conclusion

Culture is known to have its effects on honesty in trade, and on trust as a mechanism to compensate for the inevitable incompleteness of contracts. Occurrence of deceit, and mechanisms and institutions to reduce it, vary considerably across the world. For research into these mechanisms, multi-agent simulations can be a useful tool.

In intelligent agent research, much attention has been paid to trust. Little research has been published about the simulation of deceit. Publications such as [17] and [18] modeled deceit as a rational strategy to gain advantage in competitive situations. A strictly rational approach of deceit neglects the emotional impact that deceit has, not only on the deceived, but also on the deceivers. Feelings of guilt and shame result from deceiving [5]. The extent to which these feelings prevail is different across cultures [5]. People have emotional thresholds for deceit, that cannot be explained from rational evaluation of cost and benefit, but that are based on morality and cooperative attitudes [4], [13], [15]. Once deceived, people react to an extent that goes beyond rationality [4], especially when they are prosocial rather than selfish [15]. In human decision making a model based on *fair trade* prevails over a model of *opportunistic betrayal* [16]. In addition to psychological factors, rational economic motives can be given for the human inclination to cooperative behavior [14].

This paper contributes by introducing an agent model of deceit and placing it in a cultural context. It takes human deceptive behavior as a point of departure. Building on the work of [8], [9], [10], [11], [12] that modeled single dimensions of culture, this paper proposes an integrated model of culture's effects on deceit and trust. Example results have been generated that verify the implementation and illustrate that cultural effects can be generated. However, for realistic experiments, the model has to be tuned to and calibrated by observations and results of experiments, for instance to simulate effects like the ones reported by Triandis et al. [5] from human experiments on deceit across cultures. That work remains for future research.

References

1. Williamson, O.E.: Transaction cost economics: how it works; where it is headed. De Economist 146(1), 23--58 (1998)
2. Klein Woolthuis, R., Hillebrand, B., Nooteboom, B.: Trust, Contract and Relationship Development. Organization Studies 26(6), 813--840 (2005)
3. Tykhonov, D., Jonker, C., Meijer, S., Verwaart, T.: Agent-Based Simulation of the Trust and Tracing Game for Supply Chains and Networks. Journal of Artificial Societies and Social Simulation 11(3), 1 (2008) http://jasss.soc.surrey.ac.uk/11/3/1.html
4. Boles, T.L., Croson, R.T.A., Murnighan, J.K.: Deception and Retribution in Repeated Ultimatum Bargaining. Organizational Behavior and Human Decision Processes 83(2), 235--259 (2000)
5. Triandis, H.C., et al.: Culture and Deception in Business Negotiations: A Multilevel Analysis. International Journal of Cross Cultural Management 1, 73--90 (2001)
6. Zaheer, S., Zaheer, A.: Trust across borders. Journal of International Business Studies 37, 21--29 (2006)
7. Hofstede, G.: Culture's Consequences, Second Edition. Sage Publications, Thousand Oaks (2001)
8. Hofstede, G.J., Jonker, C.M., Verwaart, T.: Modeling Power Distance in Trade. In: David, N., Sichmann, J.S. (eds.) MABS 2008. LNCS, vol. 5269, pp. 1--16. Springer, Heidelberg (2009)
9. Hofstede, G.J., Jonker, C.M., Verwaart, T.: Modeling Culture in Trade: Uncertainty Avoidance. In: 2008 Agent-Directed Simulation Symposium (ADSS 2008), Spring Simulation Multiconference 2008, pp. 143--150. SCS, San Diego (2008)
10. Hofstede, G.J., Jonker, C.M., Verwaart, T.: Individualism and Collectivism in Trade Agents. In: Nguyen, N.T., Borzemski, L., Grzech, A., Ali, M. (eds.) IEA/AIE 2008. LNCS, vol. 5027, pp. 492--501. Springer, Heidelberg (2008)
11. Hofstede, G.J., Jonker, C.M., Meijer, S., Verwaart, T.: Modeling Trade and Trust across Cultures. In: Stølen, K., Winsborough, W.H., Martinelli, F., Massacci, F. (eds.) iTrust 2006. LNCS, vol. 3986, pp. 120--134. Springer, Heidelberg (2006)
12. Hofstede, G.J., Jonker, C.M., Verwaart, T.: Long-term Orientation in Trade. In: Schredelseker, K., Hauser, F. (eds.) Complexity and Artificial Markets. LNEMS, vol. 614, pp. 107--118. Springer, Heidelberg (2008)
13. Wirtz, J., Kum, D.: Consumer Cheating on Service Guarantees. Journal of the Academy of Marketing Science 32 (2): 159--175 (2004)
14. Hwang, P., Burgers, W.P.: Apprehension and Temptation: The Forces against Cooperation. Journal of Conflict Resolution 43 (1), 117--130 (1999)
15. Steinel, W., De Dreu, K.W.: Social Motives and Strategic Misrepresentation in Social Decision Making. Journal of Personality and Social Psychology 86, 419--434 (2004)
16. Olekalns, M., Smith, P.L.: Mutually Dependent: Trust, Affect and the Use of Deception in Negotiation. Journal of Business Ethics 85: 347--365 (2009)
17. Castelfranchi, C., Falcone, R., De Rosis, F.: Deceiving in GOLEM: how to strategically pilfer help. In: Castelfranchi, C., Tan, Y.H.: Trust and Deception in Virtual Societies, pp. 91--110. Kluwer, Dordrecht (2001)
18. Ward, D., Hexmoor, H.: Towards deception in agents. In: AAMAS 2003, Proceedings, pp. 1154--1155. ACM, New York (2003)
19. Burgoon, J.K., Stoner, G.M., Bonito, J.A., Dunbar, N.E.: Trust and Deception in Mediated Communication. In: Proceedings of HICSS'03 - Track1, p. 44. IEEE (2003)
20. Jonker, C.M., Treur, J.: Formal analysis of models for the dynamics of trust based on experiences. In: Garijo, F.J., Boman, M. (eds.) MAAMAW'99. LNCS, vol. 1647, pp. 120--134. Springer, Heidelberg (1999)