Computational Modeling of Uncertainty Avoidance in Consumer Behavior

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***Abstract*:** Human purchasing behavior is affected by many influential factors. Culture at macro-level and personality at micro-level influence consumer purchasing behavior. People of different cultures tend to accept the values of their own group and consequently have different purchasing behavior. Also, people in the same culture have some differences in their purchases which can be described by their personal characteristics. Therefore, this paper studies Uncertainty Avoidance dimension of Hofstede culture model in consumer behavior as well as four personality traits. The consumer model includes three important module including perception, evaluation of the alternatives and post-purchase. Our experimental results show that people of high uncertainty avoidance tend to purchase the high quality products as well as famous brands to reduce the risk of their purchases. On the other hand, people in high uncertainty tolerant culture tend to purchase the new products. The paper discusses about the validity of the proposed model based on empirical data.

***Keywords*:** Uncertainty Avoidance, Consumer behavior, Agent-based market, Computational modeling,

1. Introduction

Consumer behavior includes five main stages: need recognition, information search, evaluation of the alternatives, purchase and post-purchase [1]-[4]. Consumer behavior modeling involves computer science, artificial intelligence, marketing, sociology and psychology [5]. Consumer behavior is affected by many factors including culture and personality. What has motivated the current study is why some people take risk to purchase the new or unknown products, while some others are conservative in their purchasing. The producers and international image of the products are of high value for some people; however they afraid of purchasing new products. In contrast, some other people are open to new experiences and tend to purchase the new products. This sort of behavior is rooted in the culture at macro-level and personality at micro-level. Uncertainty avoidance dimension of culture proposed by Hofstede [6]-[9] suitably describes these differences of human behavior. Therefore, uncertainty avoidance dimension of culture is selected to study in this paper.

People inherit the general and shared knowledge from their own groups; however their behaviors are affected by their own personal preferences as well. Personality is the main reason behind these individuals' differences. Culture maintains the group values and personality make some personal preferences. Consumers' behaviors are also affected by culture and personality. Another important factor is budget which is of high value in purchasing behavior. Therefore, in addition to culture, some other personality traits and budget are taken into account for consumer behavior modeling.

Agent-based modeling is a new analytical method which is used in the modeling of social processes such as consumer behavior [10]. Each agent represents a consumer which is able to make decision autonomously based on its own preferences [10]. Therefore, applying culture and personality to cognitive modeling of consumer agents make them to behave more similar to real humans.

In this paper we propose a decision-making process for consumer agents based on uncertainty avoidance dimension of culture and four personality characteristics: QualityOriented, NoveltyTendency, RiskAversion and PriceSensitivity. Consumer agent follows three main steps to make decision: percept, evaluation of alternatives, and post-purchase. The results show that uncertainty avoiding consumers tend to purchase the products with low ambiguity, while uncertainty tolerant consumers take risk and purchase new and unknown products.

The paper is organized as follows: section 2 describes the review including uncertainty avoidance dimension of culture, personality traits related to the current study, and some agent-based modeling of consumer agents. Section 3 illustrates the proposed model in detail. In section 4, we present the experimental results and section 5 concludes the paper and proposes the future works.

2. Literature Review

Culture is defined as a set of shared knowledge among members of a group. Hofstede [6] defines four dimensions for culture including uncertainty avoidance, power distance, masculinity and individualism. However, currently, the Hofstede model includes six dimensions [9]. Of course, all dimensions of culture influence consumer behavior, but we take uncertainty avoidance into account due to the motivation of the current study. According to the Hofstede [8], uncertainty avoidance is defined as follows:

'Uncertainty avoidance deals with a society's tolerance for uncertainty and ambiguity; it ultimately refers to man's search for Truth. It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations. Unstructured situations are novel, unknown, surprising, and different from usual. Uncertainty avoiding cultures try to minimize the possibility of such situations by strict laws and rules, safety and security measures, and on the philosophical and religious level by a belief in absolute Truth; 'there can only be one Truth and we have it'. People in uncertainty avoiding countries are also more emotional, and motivated by inner nervous energy. The opposite type, uncertainty accepting cultures, are more tolerant of opinions different from what they are used to; they try to have as few rules as possible, and on the philosophical and religious level they are relativist and allow many currents to flow side by side. People within these cultures are more phlegmatic and contemplative, and not expected by their environment to express emotions'.

Countries such as Greece (112), Portugal (104), Guatemala (101), Belgium (94), France (86), Spain (86), and Korea Republic (85) have high score on Uncertainty Avoidance. Also, countries with low score on Uncertainty Avoidance are called Uncertainty Tolerant such as: Singapore (8), Denmark (23), Sweden (29), Great Britain (35), Malaysia (36), United States (46), Norway (50) and Netherlands (53).

Uncertainty avoiding consumers do not tend to purchase the new products, while uncertainty tolerant consumers are open to adopt the new products and technologies [8]. Uncertainty avoidance consumers pay much attention to the international image of the products such as famous brand cars [11] and do not tend to take risk and purchase the products with unknown brands.

Big-Five model of the personality proposed by McCrae [12]-[14], also called OCEAN (hereafter we call this model as OCEAN), is one of the models widely accepted and applied in many agent models [15]-[16]. OCEAN model includes five big traits: Openness to experience, Conscientiousness, Extraversion, Agreeableness and Neuroticism. Openness to experience is related to the novelty need [14]. According to the McCrae and Costa [14], openness people tend to try the new things, therefore openness trait is related to the novelty need. Extravert consumers tend to have high quality product since it is related to their status and their tendency to be seen in a group. Conscientiousness people are very careful about their purchasing behavior and do not like spending money for low quality products. Agreeable people are generous [14] and price is not of high importance for them. Also, neuroticism and extraversion are strongly connected to risk adoption [14]. Since it is difficult to measure the effect of each personality trait on the novelty need, quality of the product, risk and price sensitivity, we simplify these relations. Therefore, four personality characteristics related to the current study are chosen: NoveltyTendency, QualityOriented, RiskAversion and PriceSensitivity. These four characteristics are taken into account to represent the personality of the consumer agents.

There are many researches in the field of consumer behavior modeling [5], [17]-[24]. Most of them suffer from the lack of culture and personality and other cognitive features. The model proposed in [17] does not equip the agents to learning. Tran [18]-[21] extended the model by enabling the buyer agents to learn and model the reputation of seller agents and prevent communicating with non-reputable ones. Roozmand [22] proposed a model in which consumer agents model the reputation of seller agents based on three parameters: quality, price and delivery-time, separately. Also, seller agents model the reputation of buyers and consider discount for them based on their reputation. Jager [25]-[26] proposed a model for consumer agents rooted in human needs. These models apply neither culture nor personality in consumer agents. Personality has been modeled in [15]-[16] for buyer and seller agents in negotiation; however it has not been applied in consumer agents. Openness and stingy have been applied in buyer agents in [24]. Hofstede and his colleagues [27]-[34] applied five dimensions of culture separately for trading agents in negotiation but it has not been applied for consumer agents. Therefore, we aim to model the culture and personality in consumer agents. Uncertainty avoidance and four personality characteristics are chosen to be modeled in this paper.

3. Modeling Uncertainty Avoidance in Consumer Behavior

In this section we describe the market architecture and consumer agent decision-making process based on uncertainty avoidance dimension of culture. Two types of agents have been considered in this model: consumer agent and seller agent. In this paper we focus only on formalizing the consumer agent decision-making process. Seller agents play the role of product providers and they are not equipped with learning or any cognitive mechanism in the current version. The model has been implemented based on the idea of MASQ Meta model [35]. Figure 1 shows the general architecture and main transactions of the proposed model. The market model is inspired by Roozmand [36].

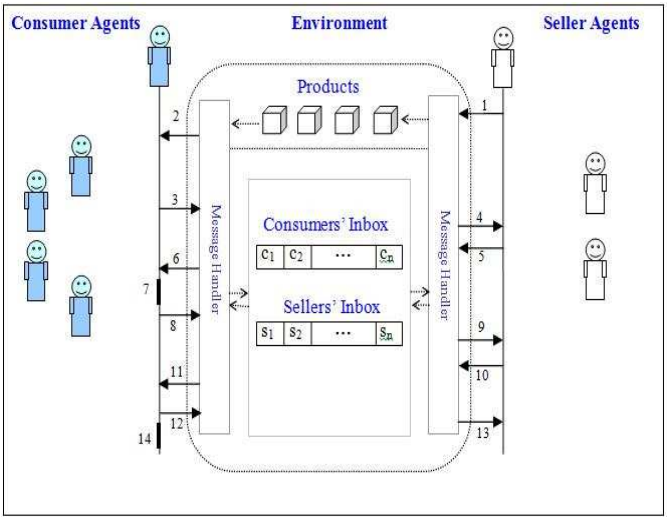

Figure 1. Market Model and Transactions

We describe different parts of the model in the following

subsections. Subsection 3.1 includes the market elements. Subsection 3.2 describes the main transactions, and finally in subsection 3.3 the consumer agent decision making process and related formulas are illustrated.

3.1 Market Elements

The framework includes three main elements: consumer agent, environment, and seller agent. These elements are described below:

Consumer agent plays the role of a consumer and purchase products in the market. Consumer agents make decision to purchase a product based on their own culture (uncertainty avoidance) and their personal characteristics.

Seller agent produces different products and presents them in the market based on the production date (time) of the product. We don't focus on internal decision making process of seller agents since the main focus of this paper is on consumer agent's modeling.

Environment is implemented as a java class and facilitates the agents' communications. Environment contains three important parts: products, inboxes, and message handler.

- **Message handler** is a set of functions to facilitate the agents' communications with environment. Agents do not directly interact with environment. All of their messages and requests are given to the message handler. Message handler checks the message and does the appropriate action. For example, a consumer agent requests for seeing the products in the market. Then, message handler checks the message and extracts the content of the message and accesses the products stored in the environment and retrieves the result for the consumer agent.
- **Product** is a data structure which enables the seller agents to place their products into this structure. It is implemented as an array. Also, consumer agents are able to perceive the products. Transactions are facilitated by the message handler.
- **Consumers' and sellers' inboxes** are considered to facilitate the consumer and seller agents' communications. Each consumer and seller agent has his own inbox. For example, C1 in figure 1 indicates the inbox for consumer agent 1. The inbox is an array which stores all sent messages by other agents to consumer agent 1. Consumer agent 1 checks his own inbox and retrieves the messages by the use of message handler functions. In addition, assume that a seller agent is going to send a message to consumer agent 1. The seller agent calls a specific function of message handler which is considered to put the messages into agents' inboxes. The function extracts the public part of the message and finds the receiver agent (consumer agent 1) and put the message in C1 (see figure 1).

3.2 Market Transactions

The model represents many transactions which are shown in figure 1. Here, we describe these transactions in detail.

1. Once a seller agent is created, he aims to demonstrate his products in the market. Therefore, he asks the message handler to add his products into the environment to be seen by all consumer agents. Of course, if the seller agent produces a new product later, he does this transaction again.
2. Consumer agents perceive the environment (environment) and update their knowledge about the products in the market. In the current simulation, each consumer agent perceives the environment in each time unit of simulation.
3. A consumer agent sends a message to the sellers who they have the product that the consumer agent requires. The consumer agent initializes the request's messages and asks the message handler to put the messages in sellers' inboxes.
4. Each seller agent checks his own inbox to find the new messages. In fact, he asks the message handler to do it for him.
5. When seller agent sees a request message from a consumer agent, he adjusts the bid including the necessary information of requested product and sends it back to the consumer agent.
6. The consumer agent receives all bids from seller agents.
7. The consumer agent evaluates the bids and selects the best option.
8. The consumer agent sends a message to the selected seller agent and informs him that consumer agent is going to purchase the product from him.
9. Selected seller agent receives the message and,
10. Deliver the product. Actually, he sends the real attributes of the product. It can be same as the attributes of the bid or possibly different.
11. The consumer agent receives the product and,
12. Pay the money.
13. The seller agent receives the money.
14. The consumer agent evaluates the real attributes of the product and updates his trust about the seller.

3.3 Consumer Agent Decision Making Process

According to the focus of this paper on modeling of consumer agent, in this subsection we describe the consumer decision making process as well as details of formalizing the model. The consumer agent decision-making process includes three important modules: percept, evaluation of alternatives, purchase and post-purchase. Also, there is a state variable that holds the estimation of trust about seller agents. We describe the details of each module:

Percept: Percept module uses the 'message handler' of environment to access the products in the market. The function is defined as:

$$seeSellersProducts() \rightarrow Products \qquad (1)$$

Products are the result of seeSellersProducts () function and contain the list of available products in the market as well as their sellers. Transaction 2 in subsection 3.2 does this action. Then, the consumer agent sends request messages to the sellers who have the product that the consumer agent requires (transaction 3).

Evaluation of Alternatives: A consumer agent receives all bids from sellers (transaction 6) and evaluates the bids to choose the best option (transaction 7). The consumer agent evaluates the alternatives based the following function*:*

$$\arg\max U_c^{Pr}(UA_c, Personality_c, Product_s, Trust_c^s, Budget) \rightarrow [0,1] \quad (2)$$

The consumer agent is able to purchase the product having enough money (Budget>price). UA_c and $Personality_c$ represent the Uncertainty Avoidance dimension of culture and personality of consumer agent c. *Products* shows the product attributes of seller s. $Trust_c^s$ represents the trust of consumer agent c about seller agent s. The function U evaluates the value of each product and arg max returns the product with highest value. The idea of Hofstede [30] has been used but extended to model the utility function.

$$U_c^{Pr} = w_{quality} * Pr_{quality} + w_{novelty} * Pr_{novelty} - w_{risk} * Pr^s_{ambiguity} - w_{price} * Pr_{price} \quad (3)$$

In which U_c^{Pr} indicates the utility value of product *Pr* for consumer agent *c*. *Also,* $w_{quality}+w_{novelty}+w_{risk}+w_{price}=1$ and represent the importance of quality, novelty, risk and price for the consumer agent *c*. Pr_k shows the attribute *k* of product *Pr*. For example, $Pr_{quality}$ shows the quality of product *Pr*. The weights on quality, novelty, risk and price are rooted in consumer agent c's culture and personality and calculated as follows:

$$w_{quality} = UA * QualityOrient ed \quad (4)$$

$$w_{novelty} = (1-UA) * NoveltyTen dency \quad (5)$$

$$w_{risk} = UA * RiskAversi on \quad (6)$$

$$w_{price} = PriceSensi tivity * (1-Bodget) \quad (7)$$

And finally the weights are normalized based on the following equation:

$$w_i = w_i / [\sum_{k=1}^{4} w_k] \quad (8)$$

For the sake of simplicity, $Pr_{quality}$, $Pr_{novelty}$ and Pr_{price} are included in the product and simply can be extracted. However, $Pr^s_{ambiguity}$ is calculated based on the product itself and its seller. Two important factors are *product brand* and trust about the product's seller. Product brand indicates how a product is reliable and is quantified in the interval [0, 1]. The value more close to 1 represents the well-known brands and value closer to zero shows unknown brands. Unknown brands increase the risk. Trust is another important factor affect the risk. Lower trust about a seller will increase the purchasing risk from that seller. Trust is in the interval [-1, 1]. Trust has been considered since one product can be sold by different sellers. Therefore, $Pr_{ambiguity}$ is calculated as follows:

$$Pr^s_{ambiguity} = (1-Pr_{brand}) * [\begin{cases} 1-Trust_c^s & Trust_c^s \geq 0 \\ 1+|Trust_c^s| & Trust_c^s < 0 \end{cases}] \quad (9)$$

Therefore, consumer agent *c* selects the best option based on utility formula (2) and sends a message to the selected seller s' (transaction 8).

Purchase: consumer agent *c* receives the product and pays the money (transactions 11 and 12).

Post purchase: Assume the scenario that the selected seller s' delivers the product to consumer agent *c*. The initial trust about all sellers is set to zero at the beginning of the simulation. Consumer agent *c* receives and extracts the real attribute values of the product. Assume that $Pr'_{quality}$ represents the real quality of the product. Reinforcement learning is used to update the consumer agent *c*'s trust about seller s'.

$$Trust_c^s(t) = Trust_c^s(t-1) + (1-\mu) * Trust_c^s(t-1) \quad (10)$$

$Trust_c^s(t)$ Indicates the trust of consumer agent c about seller s on quality at time t. μ is called cooperative factor and is calculated as follows:

$$\mu = w_{quality} * \max\{(Pr'_{quality} - Pr_{quality}), \mu_{\min}\} \quad (11)$$

In which $\mu_{\min}$ shows the minimum value of cooperative factor in formula 11. If $Pr'_{quality} - Pr_{quality} > 0$, it means that seller s' has delivered the product with a quality higher than what consumer agent *c* has evaluated at the time of purchase. Therefore, the trust about seller is positively increased by the rate of μ. If $Pr'_{quality} - Pr_{quality} = 0$, then the seller agent s' has delivered the product with the same quality as what he has offered. In this situation, the trust about seller s' is increased with the rate $\mu_{\min}$. $Pr'_{quality} - Pr_{quality} < 0$ means that seller agent cheated the consumer agent *c* and his trust is reduced.

4. Experimental Results and Discussion

The model has been implemented with Repast Simphony [37]. Three test scenarios are taken into account to test the agent behavior in the market. The first test aims to measure the consumer purchasing differences at the macro-level. Two groups of consumer agents are considered with significant cultural differences; however the other parameters are generated based on the same distribution for both groups. Also, two groups of sellers exist in this test.

100 consumers are categorized into two groups. One group represents the consumers with high uncertainty avoidance culture and the second represents the uncertainty tolerant culture, however, the other characteristics are generated almost the same for both groups. Personality traits

are generated based on normal distribution: NDpersonality-Traits (mean = 0.5, SD=0.2) in which personality-Traits = {Quality-Orientated, NoveltyTendency, RiskAversion, PriceSensitivity}. Also, the budget is generated based on normal distribution: NDBudget(mean = 0.5, SD, 0.2). Each consumer agent purchase 50 products.

- Group 1 (c1-c100): These consumer agents belong to the high uncertainty avoidance culture. NDUA(mean= 0.8, SD, 0.05).
- Group 2 (c101-c200): These consumer agents belong to the high uncertainty tolerant culture. NDUA(mean= 0.2, SD, 0.05).

The two groups of sellers are as follows:

- Group 1 (s1 – s10): These seller agents sell new products of all brands. The attributes of the products are generated based on the normal distribution: NDnovelty (mean=0.8, SD= 0.05), NDquality (mean=0.5, SD= 0.15), NDbrand (mean=0.5, SD= 0.15). Price is calculated as AVG (novelty, quality, brand). It means that the higher novelty, quality and brand lead to the higher price. The seller agents are honest and do not tend to cheat the consumer agents. NDi (mean, SD) shows the normal distribution for generating values for attribute i of each product. Mean and SD are two parameters used in normal distribution which show the mean and standard deviation of the distribution, respectively.
- Group 2 (s11 – s20): These seller agents sell high quality, and famous brands. The attributes of the products are generated based on normal distribution: NDnovelty(mean=0.5, SD= 0.15), NDquality(mean=0.8, SD= 0.05), NDbrand(mean=0.8, SD= 0.05).

Table 1 represents the average result of 10 runs. Results show that consumer agents who belong to the uncertainty tolerant culture are open to purchase the new products. As can be seen in table 1, consumer agents of uncertainty tolerant culture have bought more products from sellers of group 1. On the other hand, consumer agents who belong to the uncertainty avoidance culture do not take risk to purchase the new products when they have not any knowledge about them. These consumers concentrated on products provided by sellers of group 2 who sell high quality and famous brand products.

Table 1. Average of Consumer Purchases from Each Seller's Group

Consumer Agents	Purchase from Seller Agents: Group 1	Purchase from Seller Agents: Group 2
Group 1: Uncertainty Avoidance	16.7%	83.3%
Group 2: Uncertainty Tolerant	64.2 %	35.8%

In the second test, the effect of personality traits: NoveltyTendncy and RiskAversion are measured on adopting the new products in the same cultural context. Four groups of consumer agents are taken into account. Uncertainty tolerant culture is considered in this test for all four groups: ND_{UA} (mean=0.2, SD= 0.05). Also, QualityOriented and PriceSensivity traits are generated based on the normal distribution with mean= 0.5 and standard deviation= 0.15, and are the same for all four groups. NoveltyTendency and RiskAversion are generated differently for four groups:

- Group 1 (c1-c50): These consumer agents enjoy the high NoveltyTendency and low RiskAversion personality traits: NDNoveltyTendency(mean= 0.8, SD, 0.05) and NDRiskAversion(mean= 0.2, SD, 0.05).
- Group 2 (c51-c100): These consumer agents enjoy the high NoveltyTendency and high RiskAversion personality traits: NDNoveltyTendency(mean= 0.8, SD, 0.05) and NDRiskAversion(mean= 0.8, SD, 0.05).
- Group 3 (c101-c150): These consumer agents enjoy the low NoveltyTendency and low RiskAversion personality traits: NDNoveltyTendency(mean= 0.2, SD, 0.05) and NDRiskAversion(mean= 0.2, SD, 0.05).
- Group 4 (c151-c200): These consumer agents enjoy the low NoveltyTendency and high RiskAversion personality traits: NDNoveltyTendency(mean= 0.8, SD, 0.05) and NDRiskAversion(mean= 0.8, SD, 0.05).

20 seller agents are considered who sell all kind of products. The attributes of products are generated based on uniform distribution to cover all possible inputs. Uniform distribution generates the data as follows: UDi(n =100, min= 0.01, max= 0.99). *n* represents the number of generated data, min and max represent the minimum and maximum bound of uniform distribution, respectively.

The results show that consumer agents of group 1 concentrates on novelty attributes of products more than other groups, while consumer agents of group 4 tend to avoid purchasing the new products more than other groups. This test shows that personality influences the consumer purchasing behavior beside cultural values. The results describe that why people have different behavior while they belong to the same culture and even who have born and bred in the same families. Table 2 shows the average of novelty of products purchased by different consumer agent groups.

Table 2. Average of Products Novelty Purchased by Each Consumer Group

	Group 1	Group 2	Group 3	Group 4
Average of Products Novelty	0.899	0.713	0.651	0.487

In the third test, we show how the trust plays the role in consumer purchasing behavior. Therefore, two groups of seller agents are considered in which the sellers of one group tend to cheat the consumers. They offer high quality products but deliver the low quality ones.

- Group 1 (s1 – s10): These sellers offer high quality products and deliver low quality products. The attributes of the products are generated as follows: NDquality(mean=0.8, SD= 0.05), NDbrand(mean=0.5, SD= 0.15), NDnovelty(mean=0.5, SD= 0.15). However they deliver the product with quality q-r, in which r is a random value in the interval [0, 1].
- Group 2 (s11 – s20): These sellers offer and deliver high quality products. The attributes of the products are generated as follows: NDquality(mean=0.8, SD= 0.05), NDbrand(mean=0.5, SD= 0.15), NDnovelty(mean=0.5, SD= 0.15).

200 consumer agents are considered in the market. Each consumer agent tends to purchase 50 products. Culture and personality of the consumer agents are generated based on normal distribution, mean = 0.5 and standard deviation = 0.15. The average of 10 runs is represented in table 3.

Table 3. Average of Sold Products by Each Seller Group

Seller Agents	Sales of Seller Agents: Group 1	Sales of Seller Agents: Group 2
Average of Sold Products	3574.6	6425.4

Table 3 shows that seller agents, who cheat the consumers, are not successful in the market; even though they can make much more income than others at the beginning of the market.

There are some empirical data which support our assumptions and our experimental results. De Mooij [11] found that uncertainty avoidance is positively correlated with international image of the car tendencies in Europe (r = 0.70***). Famous international image reduces the risk of purchase. In the current paper it is called as product's brand. Also, Hofstede [38] studies how people in different countries adopt the new technologies. He used the data of World Bank (1999, 2000, 2001) [39] and found the negative correlation between uncertainty avoidance and adopting the new technologies. He found the correlations -0.41*,-0.06, -0.77***, -0.20, -0.39*, -0.46* with adopting Radios, TV Sets, PCs, Faxes, Internet Hosts, and Mobile Phones, respectively. It shows that adopting the products that have more ambiguity such as PCs, has significant negative correlations with uncertainty avoidance; however, we see very low negative correlation with TV Sets and faxes. Perhaps, it can be explained by the high ambiguity and low risk of using these products. Adopting the new technologies and products has been considered as novelty in the current paper (see formula 5).

5. Conclusion and Future Work

In this paper we proposed a consumer model based on uncertainty avoidance dimension of culture and four personality traits. Environment plays the main role in agent interactions. It facilitates the message transferring between consumer and seller agents. Perception, evaluation of alternatives and post-purchase are the key modules considered in consumer agent. Our experimental results shows that consumer agents belong to high uncertainty avoidance culture tend to purchase famous brand and take the actions with lowest risks. On the other hand, consumer agents who belong to high uncertainty tolerant are more open to adopt the new products and technologies. Also, we showed how personality makes some individual differences in consumer purchasing behavior.

In the current version of the paper we took only one culture dimension into account according to the motivation of the current study; however, other dimensions of culture play very important role in consumer purchasing behavior. We would suggest modeling the other dimensions of culture in consumer behavior as future work.

References

[1] J.F. Engel, R.D.Blackwell & P.W.Miniard, "Consumer Behavior, Hinsdale (Ill)": Dryden; D.L.Loudon, 1990.

[2] A. J. Della Bitta, "Consumer Behavior", New York, McGraw-Hill, 1993.

[3] J. Mowen, "Consumer Behavior", Englewood Cliffs (NJ): Prentice Hall, 1993.

[4] Ph. Kotler, "Marketing Management", Englewood Cliffs, NJ.: Prentice Hall, 1995.

[5] T. Zhang, D. Zhang, "Agent-based simulation of consumer purchase decision-making and the decoy effect". Pages: 912-922. , 2007.

[6] G. Hofstede, "Culture's consequences: international differences in work-related values". Beverly Hills, CA: Sage Publications, 1980.

[7] G. Hofstede, "Cultures and Organisations: Software of the Mind. Harper Collins Business", Philadelphia,P. A,1991.

[8] G. Hofstede, G. J. Hofstede, "Cultures and Organizations: Software of the Mind". Revised and expanded 2nd Edition. New York: McGraw-Hill USA, ISBN 0-07-143959-5. 436 pages, 2005.

[9] G. Hofstede, G. J. Hofstede, and M. Minkov, "Cultures and Organizations: Software of the Mind". Revised and expanded 3rd Edition. 3rd ed. New York: McGraw-Hill USA, 2010.

[10] N. Gilbert, "Agent-Based Models". Sage publication. ISBN: 978-1-4129-4964-4 (pbk), 2008.

[11] M. De Mooij, "Consumer Behavior and Culture: consequences for global marketing and advertising". Sage Publications India. 2003.

[12] R. R. McCrae, & O. P. John, "An introduction to the Five-Factor Model and its applications". Journal of Personality, 60, 175–215, 1992.

[13] R. R. McCrae, & P. T. Costa, "Toward a new generation of personality theories: Theoretical contexts for the five-factor model". In J. S. Wiggins (Ed.) The five-factor model of personality: Theoretical perspective. Pp: 51-87. New York: Guilford Press, 1996.

[14] R. R. McCrae, & P. T. Costa, "Personality in Adulthood: A Five-Factor Theory Perspective (2nd ed.)". New York: Guildford, 2003.

[15] F. Nassiri-Mofakham, N. Ghasem Aghaee, M. A. Nematbakhsh, A. Baraani, "A Personality-Based Simulation of Bargaining in E-Commerce". Journal of Simulation and gaming, 39(1). March. pages: 83-100. Sage publications, 2008.

[16] F. Nassiri-Mofakham, M. A. Nematbakhsh, N. Ghasem-Aghaee, A. Baraani, "A Heuristic Personality-Based Bilateral Multi-Issue Bargaining Model in Electronic Commerce", Journal of Human-Computer Studies, Elsevier, Vol. 67, No. 1, pp. 1-35, 2009.

[17] J. M. Vidal, and E. H. Durfee, "The Impact of Nested Agent Models in an Information Economy". In Proceedings of the Second International Conference on Multi-Agent Systems. Pages: 377-384, 1996.

[18] T. Tran, R. Cohen, "Reputation-Oriented Reinforcement Learning Strategies for Economically-Motivated Agents in Electronic Market Environments". PhD Thesis, School of Computer Science, University of Waterloo, 2003.

[19] T. Tran, R. Cohen, "The Stability of Electronic Marketplaces Where Buying Agents Use Reliability Modeling to Select Selling Agents". Published in Journal of Business and Technology (JBT), Special Issue on Business Agents and the Semantic Web, Vol. 1, No. 1, pages 62-68, 2005.

[20] T. Tran, "A Reliability Modeling Based Strategy to Avoid Infinite Harm from Dishonest Sellers in Electronic Marketplaces. Published in Journal of Business and Technology (JBT)", Special Issue on Business Agents and the Semantic Web, Vol. 1, No.1, pages 69-76, 2005.

[21] Tran, T. Cohen R. "Improving user satisfaction in agent-based electronic marketplaces by reputation modeling and adjustable product quality", Autonomous Agents and Multiagent Systems, 19-23 July 2004 Page(s):828 – 835, 2004.

[22] O. Roozmand, M. A. Nematbakhsh, A. Baraani, "An Electronic Marketplace Based Reputation and Learning, Journal of Theoretical and Applied Electronic Commerce Research", 2(1): 1-17, 2007.

[23] O. Roozmand O, N. Ghasem Aghaee, "Applying k-nn learning and reinforcement learning for buyer and seller agents", Proceeding of 12th international conference of computer society of Iran. Shahid beheshti, iran, 2007.

[24] A. Barzegar, A. Jahanbani, O. Roozmand, Openness, "Conscientiousness and Stingy for Buyer and Seller Agents in Electronic Marketplace". International Journal of Computer Theory and Engineering 2 (3):1793-8201, 2010.

[25] W. Jager, Modelling Consumer Behaviour. PhD thesis. Groningen, May, 2000.

[26] M. Janssen, W. Jager, "An integrated approach to simulating behavioural processes: A case study of the lock-in of consumption patterns". Journal of Artificial Societies and Social Simulation (JASSS), vol 2, no.2, 1999.

[27] G. J. Hofstede, M. Jonker Catholijn, S Meijer, and T Verwaart. "Modeling Trade and Trust across Culture. In 4th International Conference", May 16-19, pp.120-134, , Berlin, Heidelberg: Springer Verlag, 2006.

[28] G.J, Hofstede, M. Jonker catholijn, and T Verwaart. "Modeling Power Distance in Trade". In N. David, J.S. Sichman, editors, Multi-Agent-based Simulation IX, International Workshop, MABS 2008, Revised Selected Papers, LNAI 5269, pp.1-16, Berlin, Heidelberg: Springer Verlag, 2007.

[29] G.J. Hofstede, M. Jonker Catholijn, and T Verwaart. "Individualism and Collectivism in Trade Agents". In Nguyen, N.T., Borzemski, L., Grzech, A., Ali, M., editors, New Frontiers in Applied Artificial Intelligence, Proceedings of IEA/AIE 2008, LNAI 5027. pp. 492-501, Berlin, Heidelberg: Springer Verlag, 2008.

[30] G.J. Hofstede, G.J, M. Jonker catholijn, and T Verwaart. "Modleing Culture in Trade: Uncertainty Avoidance". In Agent-Directed Simulation Symposium (ADSS'08), Spring Simulation Multiconference, pp. 143-150, San Diego: SCS, 2008.

[31] G.J. Hofstede, G.J, M. Jonker Catholijn, and T Verwaart. "The Influence of Culture on ABMP Negotiation Parameters". In ACAN2009, The Second International Workshop on Agent-based Complex Automated Negotiations, May 11, Budapest, Hungary, 2009.

[32] G.J. Hofstede, AJ Czaplewski, and T Verwaart. "Long-term Orientation in Trade". In K. Schredelseker and F. Hauser, editors, Complexity and Artificial Markets, Lecture Notes in Economics and Mathematical Systems

614, pp. 107-119, Berlin, Heidelberg: Springer Verlag, 2008.

[33] G.J Hofstede, C.M Jonker, and T Verwaart. "Computational Modeling of Culture's Consequences". Paper accepted for presentation at MABS 2010, 11 May 2010, Toronto, Canada, 2010.

[34] G.J Hofstede, C.M Jonker, and T Verwaart. "Cultural Differentiation of Negotiating Agents". Group Decis Negot, doi: 10.1007/s10726-010-9190-x, 2010.

[35] J. Ferber, Stratulat, T., & Tranier, J. "Towards an integral approach of organizations: the MASQ approach". In V. Dignum (Ed.), Multi-agent systems: Semantics and Dynamics of Organizational Models: IGI, 2009.

[36] O. Roozmand, N. Ghasem Aghaee, G. J. Hofstede, M. A. Nematbakhsh, A. Baraani, "Modeling power distance in consumer behaviour". Presented in University of Isfahan, Iran (unpublished work), 2010.

[37] M.J. North, N.T. Collier, J. R. Vos, "Experiences Creating Three Implementations of the Repast Agent Modeling Toolkit, ACM Transactions on Modeling and Computer Simulation". 16 (1): 1–25, doi:10.1145/1122012.1122013, 2006.

[38] Hofstede, G. J, "Adoption of Communication Technologies and National Culture, Systèmes d'Information et Management", Vol. 6, n°3, pp. 55-74, 2001.

[39] World Bank (1999, 2000, 2001): World Development Indicators, http://www.worldbank.org.

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