# Demonstration of a Multi-Agent Simulation Model of Trust in Supply Chains

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**Abstract**

The trust and tracing game - played by humans - is a research tool designed for study of trust in commodity supply chains. Preliminary observations from the game suggest that rational choice is to some extent dominated by player's personal preferences. Multi-agent simulation systems are being developed for comparison between behavioural models and experimental results. A prototype will be demonstrated and directions for future development will be presented. The purpose of this demonstration is to get in touch with AI researchers working in related areas.

## 1. Description of the Trust and Tracing Game

The trust and tracing game[1] is a research tool designed for study of actor behaviour in commodity supply chains. The focus of study is on trust in the stated quality of the commodities. The game is played by a group of persons that play the roles of producers, middle-men, retailers, or consumers. In the initial state, consumers, retailers and middle-men are supplied with (artificial) money. Producers are supplied with envelopes of different colours representing lots of different product types A, B, and C. Each lot is of either low or high quality, represented by a ticket covered in the envelope. Each combination of product type and quality grade has a different consumer satisfaction value (Table 1). Producers are informed about the quality of each lot, but other players may not open the envelopes. Buyers must either trust sellers or involve a tracing agency, at the cost of a tracing fee. If the tracing agency finds an untruthful quality statement, the seller will be punished with a fine and public disgrace. So a seller may put some money and her reputation at stake by deceiving buyers or by trusting her supplier. A bottle of wine is the reward for the winners in each player category. In the consumers category the player having gained the most satisfaction points is the winner; in other categories profit is the criterion (Fig 1).

**Table 1: Consumer satisfaction value for product types A, B, and C, by quality**.

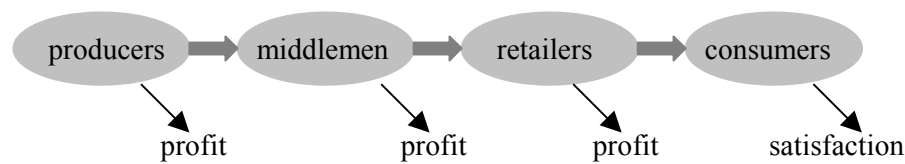| Quality grade | A | B | C |
|---------------|---|---|----|
| Low | 1 | 2 | 3 |
| High | 2 | 6 | 12 |

**Figure 1:  Commodity flow and performance criteria.**

## 2.  Multi-Agent Simulation Model

A pay-off matrix has been formulated, assuming rational choice[1]. However, preliminary game observations suggest that rational choice is influenced by personal preferences for taking risk, being honest, reputation, and interpersonal relations. People do not only maximize profit. They also follow rules of appropriateness. Multi-agent systems are being developed for study of these phenomena. We demonstrate a prototype using the Swarm simulation environment[2]. The purpose of this prototype is to assess feasibility of using multi-agent models for research of behaviour in supply chains.

The prototype comprises player agents for the roles of producers, middlemen, retailers, and consumers, and a tracing agent that may on request assess the quality of a product and impose a fine in case of deception. The trading agents are composed of processes for:

- *Needs determination*: determine if an agent intends to buy or sell; consumers always buy; middlemen and retailers buy if stocks is below threshold; producers, middlemen, and retailers sell any product in stock.
- *Trade partner selection*: agents intending to sell advertise; buyers contact sellers with trust-based preference; sellers may refuse (busy or distrusting).
- *Cheating decision*: the seller randomly decides whether to cheat or not, weighted with an "honesty" parameter and trust in the trade partner.
- *Price negotiation*: based on agent's belief about reasonable price; agents will terminate negotiations that do not satisfactorily proceed.
- *Trust-or-trace decision*: after successful transaction buyer decides whether to request a trace or not, based on its trust in the trade partner.
- *Trust maintenance*: agents maintain trust for any other agent they have done business with, based on the outcome of negotiations and traces.
- *Price belief maintenance*: adjust price belief based on negotiation results.

With this prototype the feasibility of multi-agent systems for supply chain research has been demonstrated. Currently we are developing more extensive models and exploring other agent platforms.

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[1] Meijer, S. and G.J. Hofstede  "The Trust and Tracing game" In: *Proc. 7th Int. workshop on experiential learning.* IFIP WG 5.7 SIG conference, May 2003, Aalborg, Denmark.
[2] http://wiki.swarm.org/wiki/Main_Page