MICROCREDIT PRACTICES APPLIED DO E-SUPPLY CHAIN MANAGEMENT

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ABSTRACT
Mohamed Yunnus, founder of the Grameen Bank and winner of the 2006 Noble Peace Prize, introduced a new financial strategy to the world calling it MicroCredit. The practices involve loaning small amounts of money to societies’ poorest people so as to allow them to develop small scale businesses. In this research an agent architecture emulating these practices on a competitive multi agent trading platform is presented. The agent is named MicroTeam and was a contestant in the 2007 TAC SCM competition qualifying rounds. It achieved an average final result of 1.8 million with an initial loan of only 100,000 monetary units proving the applicability of the concept even among highly competitive agents such as last year’s winner. The proposed agent adaptations mainly regard introduction of credit limits and client request analysis following the developed evaluation function.

KEYWORDS
Microcredit, Supply Chain, Agents, Business Strategy, Simulation, TAC SCM.

1. INTRODUCTION

The word “microcredit” emerged around the seventies in the context of economical crises. Most nations were still recovering from a worldwide conflict, World War II and at that time most funds were still being directed towards military projects. This led to a social degradation of societies which manifested itself in phenomena such as extreme poverty, hunger and many forms of corruption (economical, political…) (Eichengreen, 1994) (Cantor, 1985). To prevent an economical recession many economists tried to find solutions for this specific problem. Microcredit was one of the most widely accepted mechanisms in the search for a solution since its application is not confined with the most powerful nations in the world but also with citizens living in sub developed countries like most African and western Asian nations.

Microcredit can be briefly defined as program that provides credit for self-employment and other financial and business services (including savings and technical assistance) to very poor people [3]. It was
formally introduced by professor Mohammad Yunus [2] who is a reputed economist, founder of the Grameen Bank [1] and winner of the 2006 Nobel Peace Prize. The Grameen Bank was founded in Bangladesh with funds from several kinds of organizations including governmental, institutional and nonprofit ones. This bank’s policies included loan concessions to extremely poor people who have their skills unutilized and the ability to start their own business with a small amount of money, which can later be returned with very low or even no interests (Morduch, 1985). The bank also has many contracts with several companies to provide services regarding the basic needs of the individuals that require the loans. These services include communication infrastructures and supply of energy and water. Up to 2005 the Microcredit Summit included more than 300 microcredit institutions reaching a total of approximately 82 million clients, 78% of them being among the poorest people in the world (Figure 1 [4] illustrates these results).

Currently microcredit limits vary according to the continent where there are applied. For sub developed countries those limits are around 200 score points, although there are some cases where the loans are only of 30 score points [5]. In Europe those limits are quite higher; in fact one of the most successful cases had a credit of 40,000 Euros to build a carpenter shop [6].

In this approach a TAC SCM agent simulates a microcredit client in a competitive business environment. The chosen platform does not limit the credit given to trading agents but the agent at hand has a fixed small limit, only large enough to make an entry in the market. Following a set of rules similar to the ones that a real microcredit client would follow, the agent succeed in constructing a solid small-scale business against highly competitive agents participating in the 2007 TAC SCM official competition. The remainder of the paper is organized as follows. Section 2 briefly describes the used trading platform. Section 3 presents the relevant features of the proposed agent. Section 4 evaluates its performance and finally in Section 5 conclusions are presented and future work is discussed.

2. TAC AGENT COMPETITION

In this section a brief description of the TAC SCM game is presented. For further reading the follow specification can be found in document1.

In the game six agents compete for the highest balance in their respective bank account. The agents’ role is to manage an entire personal computer (PC) supply chain trying to make profit out of it. To do so in a period of 219 simulated work days, the agents pass throw a series of processes. They must apply to customer requests, process customer orders, deal with the available suppliers and finally produce and deliver final

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1 http://www.sics.se/tac/tac07scmspec.pdf
products. The platforms supporting the mentioned processes are based on client-server architecture. The sequence of these activities is shown in Figure 2 (Sherstov, 2005).

![Figure 2. TAC SCM Architecture Protocol](image)

2.1 Customer Request

In each day customers contact the trading agents requesting PCs. The requests contain information on the type and quantity required, the reservation price, which represents the maximum price that the client is willing to pay per unit, and the due date. For each request, clients receive at most six proposals and choose to order from the agent that presents the cheapest price. The number of requests varies during a simulation session according to offer and demand market principles (Kiekintveld, 2005).

2.2 Process Customer Orders

Each tradable computer is made of four types of components including CPUs, motherboards, memories and hard drives. The combination of the several brands of components allows assembling sixteen different combinations of PCs. Every time an agent needs to buy components it must make an offer to suppliers selling them. Suppliers also have limited production capacities and they are not totally reliable because sometimes, even after accepting a request, the components may not be delivered, simulating overloaded production facilities and penalties related to confidence and reputation measures. The agents can make proposals for a given component to all the available suppliers (selling that component).

2.3 Produce and Deliver Final Products

After having the components needed for assembly, the agents can send them to the factory in order to complete the final production procedures. In each day an agent has 2,000 production cycles. Each PC brand has distinct needs regarding this variable. Finally if an agent does not deliver the products in the agreed dates it will suffer a penalty, specified in the corresponding RFQ. There are other operational costs such as storage costs and negative interests that are only applicable when the bank account has a negative balance (He, 2005).

3. THE MICROCREDIT APPROACH

In this section an agent for the TAC SCM Competition is proposed. The agent tries to emulate the microcredit strategy presented. The policies involved had to suffer some adaptations due to simulator rules
and platform characteristics. Those adaptations are explained in the next sub sections and consider both theoretical and practical details.

3.1 Microcredit Limit

The simulator is oriented to large scale business involving highly competitive companies. For this reason the standard credit limit had to be raised from conventional values to about 100,000 score points. This credit margin already allows the agent to apply to a significant amount of possible deals, in the first days of the simulation. At this point it is important to mention that, for each iteration, the agent assumes that all the deals that it makes an offer to will be accepted by the involved requesters. This scenario is not realistic in a competitive environment but ensures that the credit limit is only exceeded when the production costs are underestimated. Another relevant aspect related with the credit limit is the fact that the agent only starts to apply for business in the third day of the simulation because the price reports, which are the basis for all the price calculus, are only available from the second day onward and another day is required for market stabilization. If by any reason the agent does not need to spend the total amount of credit that it is given, the remaining part of it is transferred to the next day.

3.2 Production Limits

Microcredit based companies do not have the funds necessary to have storage facilities as they quite often require fixed expenses for maintenance purposes. The TAC platform considers this problem by taxing stock maintenance of components and assembled machines. This cost had to be fully avoided, although it is not correctly scaled since it allows winning agents to maintain thousands of components in stock without paying a proportional price making this cost insignificant. Large scale agents achieve around 17 million score points as their final bank balance score, considering an average simulation meaning that all the agent slots were filled with active entities. In this case storage costs hardly overpass 1.5 million score points. The agent only buys components for a given client order and never for stocking reasons. In a microcredit environment production facilities usually do not have high brand equipments; in fact, in most cases, companies buy second hand equipments and in small amounts. To simulate these characteristics the agent tries to maintain a low factory load using at most seventy percent of its capacity. This way the remaining thirty percent are related to: not having as many production capabilities as its competitors; assuring that if an order is not delivered in time it will not be because of a factory scheduling problem; and to simulate a possible lack of required manpower for a given set of orders. This percentage distribution proved to be effective after several experiments, since it allows a good maintenance of both the factory load and the profit obtained. It is relevant to state that microcredit entities do not have the funds to sustain costs related to equipment malfunctions which are many times caused by overloading them although TAC SCM does not include this feature.

3.3 Client Request Evaluation

Since microcredit based entities have limitations in what concerns production capabilities, monetary funds are not the only variable stopping the agent from applying to a large number of client requests. In fact the microcredit agent sorts all the requests it receives from market clients, following two criteria, which have been given the same weight in the developed evaluation function. These two parameters are the available amount of time for assembling machines and the profit margin. Both parameters are expressed as branched linear mathematical functions.

Regarding the first parameter the function attempts to prize requests for long terms deliveries. Since the agent does not buy to build stocks, the proposals having deliveries dates that are six days afar from the current day or less are evaluated with the lowest function value as possible. Figure 3a depicts this concept on a graphic. The x-axis represents potential occupation needs for a given client request. The needs are a fraction where the numerator means the total amount of cycles required for the order at hand and the denominator the total amount of cycles available, which are extracted from the number of days between the current date and the delivery date. For this reason the x-values closer to point (0,0) are the ones with the higher values as they represent requests involving a low number of PCs or requests with a distant delivery
date. The main objective of this evaluation is to minimize penalty probabilities as the distance of the delivery date assumes more relevance than the amount of PCs requested. The values on the negative branch of the graphic regarding the x-axis, refer to eventual orders having the delivery date prior to the order date. This situation would doubtlessly lead to an error if accepted and so it should be discarded.

The second parameter refers to profit probabilities. The agent tries to prize client requests considering the highest profit margins attending to the previous day practiced prices. When the market demand is very close to its corresponding offer, the margins will be lower, but in any case the agent tries to extract profits according to its best expectations. If the agent is unable to win any offer in a given iteration, since there are no fixed costs, it will maintain his bank balance plus interests. Figure 3b illustrates the function used to evaluate this parameter after application of branched prizing and penalizing factors to formula 1.

\[
\text{BasePrice} = \text{MaxClientPrice} - \left(\frac{\text{MaxPrice} - \text{MinPrice}}{2}\right) + \text{MinPrice} \quad (1)
\]

MaxPrice and MinPrice values come from the simulator’s price reports for a given product, and the MaxClientPrice is the maximum amount that the client is willing to pay per unit.

3.4 Client Proposals

Since the agent cannot assume too many risks, after sorting the client proposals as explained before, it shall only apply to the ones with the highest evaluation. After several simulations, the minimum quality value was set to two hundred points. This allows the agent to apply to an average of fifteen deals per iteration considering a simulation on normal conditions.

The agent tries to adapt its profit margins according to its factory availability. If the factory occupation is superior to 70%, profit margins are raised to a maximum of 65% of the difference between the previous day’s maximum and minimum prices practiced plus the previous day’s minimum price. On the other hand, if the factory is being misused (less than 10%), then the profit is decreased to a minimum of 15% above the previous day’s difference as mentioned before.

After winning a client proposal, the agent always contacts all the suppliers present in the market in order to achieve the lowest possible price for the components that it needs. This approach is appropriated for an agent of this kind because it always buys small amounts of components when compared to all of its competitors. For large scale agents, some concerns must be taken to achieve reliable deliveries, but in this case the quantities are most often low and as of that irrelevant.

4. RESULTS

The results achieved by the agent surpassed the initial expectations, which pointed to low profit margins, having the final results values between 500,000 score points and 1 million score points.

The agent was one of the nineteen contestants in the 2007 edition of the TAC SCM competition’s qualifying rounds and was named “MicroTeam”. In the simulations the agent had the chance to compete against the previous years’ winners which have the sole goal of raising the competition level as high as possible so as to win the game with high profit margins regardless of the amounts lent by the bank.
In this context the agent achieved an average final result of 1.8 million score points as Figure 4 demonstrates.

![Figure 4. Results of TAC SCM Challenge 2007](image)

This result is quite accurate since the disruption factors are both positive and negative outliers. Considering the negative outliers and taking into account the graphics in Figures 5a and 5b it is observable that most zero games took place in simulations running on tac4 server. This happened because during the competition the agent ran on two different machines, one for each server, and the one responsible for interacting with TAC server 4 suffered from network access problems.

![Figure 5. Results of TAC SCM Challenge 2007 - Machine 3(a) - Machine 4(b)](image)

The other negative results are related with non accomplished supplier contracts leading to delays and subsequently to penalties which made the bank balance go below the credit limit of 100.000 score points (microcredit limit). Positive outliers are justified by simulations sessions where one or more agents were absent. An example of this case is simulation number 6441 in machine 4 (Figure 6) where three agents did not participate making the market demand much higher than the offer which led to extremely high profit margins. In this situation the agent achieved a final score of 15 million which is not to be considered regarding a performance analysis.
The simulation that best describes the agent's behavior occurred in machine 3 and has the number 6407. In this particular case, the agent competed in a series including agents that ended in second, fourth, eighth, tenth and fifteenth place in the end of the qualifying rounds. The agent succeeded in creating a small-scale business with a final result of approximately 230,000 score points and with the initial loan of 120,000 score points. Comparing with the agent that achieved first place (TacTex), it is observable that it needed to request a 6 million loan for a final result of approximately 12 million score points. The agent achieved a proportionally result but with a much smaller risk factor. This situation can be confirmed by analyzing Figures 7a and 7b. In Figure 7b the investment and profit cycles of the agent are clearly observable as well as the steady growth of his bank balance.

5. CONCLUSIONS

The main goal of this research was achieved as the agent was able to create a small-scale business in a competitive environment. The obtained results in the TAC SCM competition showed microcredit practices’ value and applicability. Although the theory was demonstrated, the results could have been even better if the challenge simulator had some of its features improved and faults corrected. Among this the following should be considered for the next versions. The simulator should consider constant monthly costs having their value some relation with factory production statistics. Storage costs should also have more realistic values as currently for a large-scale business they are insignificant. The server configurability should be improved to allow more market scaling operations e.g. less requests per day being those requests of one or two PCs. The server should include a performance analyzer in order to detect abnormal agent behaviors. Based on the data retrieved from this analyzer the server could autonomously take actions to partially solve the problems.
Among these actions the following should be considered: if after a period of time an agent is unresponsive the server should be able to replace it by a dummy one; if an agent at a certain moment of the game starts buying massively one type of component and disregarding profits it should be disqualifying and replace by a dummy agent. Future work in this project should focus on the negotiation mechanisms with suppliers.

Currently the agent tries to buy components at the cheapest possible prices; however it does not consider confidence measures. Improvements at this point would reduce penalty probabilities and possibly raise production prices but as penalties are quite severe, the mentioned losses would not be so relevant.

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