JAIST Repository
https://dspace.jaist.ac.jp/

Title	Negotiation Process based on Hybrid Trader with Side Payment
Author(s)	Takahashi, Satoshi; Matsuo, Tokuro
Citation	
Issue Date	2007-11
Type	Conference Paper
Text version	publisher
URL	http://hdl.handle.net/10119/4095
Rights	
Description	The original publication is available at JAIST Press http://www.jaist.ac.jp/library/jaist-press/index.html, KICSS 2007 : The Second International Conference on Knowledge, Information and Creativity Support Systems : PROCEEDINGS OF THE CONFERENCE, November 5-7, 2007, [Ishikawa High-Tech Conference Center, Nomi, Ishikawa, JAPAN]

JAPAN ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY

Japan Advanced Institute of Science and Technology

Negotiation Process based on Hybrid Trader with Side Payment

Satoshi Takahashi† **Tokuro Matsuo**‡
†‡Department of Informatics,
Faculty of Engineering,
Yamagata University,
4-3-16,Jonan, Yonezawa, Yamagata, 992-8510, Japan
† takahashi2007@e-activity.sakura.ne.jp
‡ matsuo@yz.yamagata-u.ac.jp

Abstract

This paper proposes new cooperation business model on B2B/B2C and shows effectiveness of our proposed model. We call general consumers who stand on seller hybrid traders. Ordinarily, a trader who is general consumer doesn't have enough money. We consider about traders cooperate with each other. In regard to buying items, we consider a volume discount-based trading. We propose a mechanism in which trader cooperates, buys in a lot of goods, and increases own utility. Our mechanism adopts side payment to promote increasingly cooperation with traders. Cooperative traders commit participation based on a value of side payment. Our mechanism searches for the best value of side payment in cooperation and negotiation. In our simulation, we show relationships between side payment and trader's utility.

Keywords: Hybrid-trader, Side-payment, Volume-discount

1 Introduction

In recent years, e-commerce is increasingly becoming a major part of the business world. Some researches proposed effective models as several e-commerce protocols[1][2][3][4]. As trading using the Internet develop, end-users can perform both buyers and sellers since it is easy for them to open their shops on the web[5]. Such transaction is called B2B(Business to Business)/B2C(Business to Consumer)[6]. Generally, when end-users open shops on the web, it takes less cost and money. It is easy for consumers to be sellers like a company. In this paper, we call hybrid traders such end-users. When traders sell items to general consumers, they need buy in items. Hybrid traders do not enough money to buy in items. To buy in items at a low price, some traders cooperate with each other. Namely, they buy in items as joint capital. In this case, items are sold based on volume discount from sellers such as producers, factories. If a trader has enough budgets and he/she can buy in a lot of items, price of each item goes down. Although each trader does not enough money, they can purchase in items at a lower price making purchasing community. The item, which is bought by the cooperation group is allocated based on investment values in group.

When traders cooperate with each other, it is possible to buy in cooperatively cheaper than buy in individually. As the result, each trader's utility increases. If all traders know about types of traders, they make cooperation easily.

We employ side payment mechanism to promote trader's cooperation. If traders are rational, all traders must cooperate with each other. Each trader has a certain participation incentive based on value of side payment. Side payments are given as cooperation fee from traders who want to buy in to cooperative traders who cooperate with them. If the former's utilities decrease paying side payments to cooperative traders, none search for cooperative agents. This paper proposes a mechanism in which trader's utility are becoming maximum searching for optimal side payment.

The rest of this paper consists of the following five parts. In section 2, we define several terms and assumptions. And We define hybrid traders. In section 3, we define side payment and present participation probability relates with decision of side payment. In section 4, we give a assumption for this mechanism and show result of simulation. After we present an overview of the work of other related to our research. Finally, we present our conclusion.

2 Definition and Assumption

In this section, we give some definitions of terms and assumptions in our proposed mechanism.

1. A set of agents $\{a_1, ..., a_i, ..., a_n\}$ who participate in a community. a_i is i th agent. We call hybrid trader an agent in this paper.

2. A set of items $\{g_1, ..., g_j, ..., g_m\}$ is dealt in. g_j is j th item.

3. T_l are groups in which separate participation agents. This group is separated by dependence of side payments.

4. G_i is agent a_i's budget. Budget of cooperation group is shown as $G_{\{1,2,...,n\}}$.

5. $g^k_{i,j}$ is price of item g_j to sell agent a_i. Each level of price in volume discount is shown as $k = \{1, ..., k, ..., k'\}$. When there is no discount level, the price is shown as $g^1_{i,j}$.

6. When agent a_i sells item g_j, the price is shown as $p_{i,j}$.

7. s_i is a value of side payment in which agent a_i pays other cooperative agents.

8. U_i is agent a_i's utility. U is shown as $p_{i,j} - g^1_{i,j}$. Utility is defined as agent's profit.

9. U'_i is agent a_i's utility when agent a_i deals in individually. U' is shown as $p_{i.j} - g^1_{i,j}$.

Definition 1. All agents join in a community on the Internet commercial site. Each agent joins in community group $C_{\{a_1,a_2,...a_n\}}$. Agents deal in this community group.

Definition 2. All agents can purchase all items restricted budgets.

Definition 3. Agents propose cooperation for buying-in for other agents.

Assumption 1. All items are sold based on volume discount[6]. Each item's price is decided based on the number of items traded by agents.

Assumption 2. Agent doesn't have enough budgets.

Quantity	$
1 - 10	100
11 - 50	85
51 -100	70
101 - 200	55
201 -	40

Table 1. Value of Item

Assumption 3. Participation agents depend on values of side payment. The agents decide whether they participate and cooperate based on value of side payments given from a proposing agent.

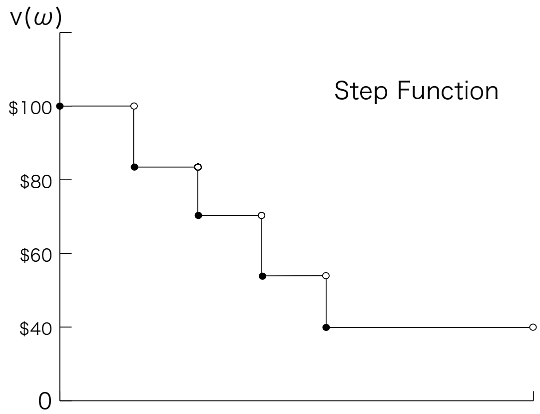

Figure 1. Volume Discount

On above assumption, all items are sold with volume discount. The item price is cheaply by number of items. Figure 1 shows stair-case graph indicating items price in volume discount. It shows prices of items are step function. Increasing number of items, price of each item gose down. Table 1 shows a concrete example of Figure 1. When traders can purchase 11 items, utility calculates on more increasingly about $15 when they purchase only one item.

2.1 Hybrid Trader

We define hybrid traders. On economic phenomena, we treat dealing between sellers and buyers. But in under continual time, same people sometimes play the seller and the buyer. And the people are end-users who only buy items basically. The sellers are special people who have a certain level of money and procedure. It is difficult to be sellers in which they pay stored cost and advertisement cost without enough money to spend in trading. However, economic activity on the Internet is no cost of their payment. Additionally, users learn indirectly about selling procedure because they use auction and group buying.

End-users do not have enough money for buying-in a lot of items. Traders who have few money can purchase by a pool of capital. One of characteristics of the Internet is that traders can cooperate many and unspecified people. In case of items are sold with volume discount, traders can purchase more items by same budget because a unit price of each item becomes a discounted price.

We define a user who plays seller and buyer as hybrid trader. Figure 2 shows model of transaction environment when hybrid trader stands on their environment. The seller only sells items. The buyer also buys items. Hybrid trader can sell and buy items.

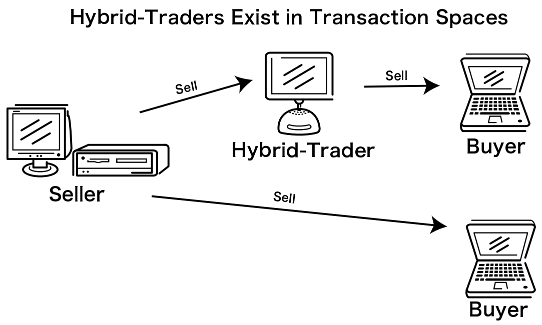

Figure 2. Hybrid Traders

2.2 Allocation of items

When a producer sells items to traders, they generally purchase in a large amount of items in a trade. Items' prices depend on quantity of items traded by agents. When agents cooperate with each other and can deal in effectively, agents are able to have good opportunity to increase their utilities. Then, how the items are allocated ?

Agents allocates the items based on percentage of investing. Total number of allocated items is equal as total number of item bought by agents. Figure 3 shows allocation of items. For example, agent a_1 allocates items in total number of items by ratio of investment G_1 on total investment G. Sum of ratio is shown as follow-

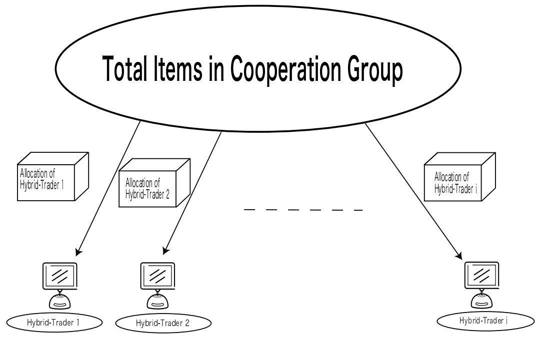

Figure 3. Allocation of items

ing formula.

$$\sum_{i=1}^{n} Gi/G = 1$$

3 Side payment

In this section, we show a protocol of cooperation and negotiation. We also show a mechanism based on side payment.

3.1 Adopting side payment

Our mechanism adopts side payment to give incentive of cooperative agent easy to cooperate and to make a coalition. When value of side payment increase, cooperative agent's incentives increase. Actually at Japanese public work projects, bid riggers were paying kickback to cooperation traders. It has two means. One is incentive for cooperation. The other is stopping to drop out of it. When an agent deals in individually, his/her utility is calculated as $U = p - g^1$. In assumption 2, agents do not have enough money. Meanwhile case of cooperative dealing, proposing agent pays price rate to get items, because he/she can gather a large amount of budgets from cooperative agents. Proposing agent's utility is calculated as $U' = p - g^k$. His/her utility increases as $U - U'$. Consequently, side payment should be paid between 0 to $U - U'$.

3.2 Depending on side payment

Cooperative agents are separated from some depending group. Each group has participation probability with depending on side payment. This is suitability at incentive of participation by side payment. For example, cooperation groups T_l are given probability $f_l(s_i)$. s_i is a value of

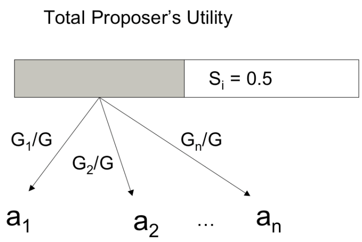

Figure 4. Allocation of side payment

side payment shown by proposing agent a_i. Cooperative agents can decide to participate in cooperation group by side payment. When value of side payments are increased, proposing agent a_i's utility reduced due to paying side payment. Though many cooperative agents join in the purchasing group.

3.3 Dealing protocol with side payment

In this section, we show a protocol of dealing.

Protocol

- Agent a_i is a proposing agent. a_i proposes about cooperation of buying items g_j for other agents. All agents know discount rate of items.

- The proposer a_i shows value of side payment as s_i.

- Other agents commit participation by side payment.

- The proposer a_i gathers money from cooperation group and buys in the items.

- The items are allocated by each contribution.

- Each agent sells the items by own accountability.

- The proposer pays side payment to all cooperative agents. In this payment, the proposer pays $s_i * (U - U')$ with contribution.

Figure 4 shows allocation of side payment. When side payment is 0.5 by proposer's utility, cooperators get side payment based on rate of their investments. For example, investment ratio is like G_1/G.

Quantity	$
$1 \sim 5$	7
$6 \sim 10$	5.5
$11 \sim$	3

Table 2. Volume Discount

3.4 Examples

We consider that there are two agents and one tradable item. Agent a_1 proposes to other agents about item g_1. Item g_1 is discounted on 3 level. Table 2 shows the item price based on number of items. Budget G_1 of the agent a_1 is \$30. If no agents cooperate, agent a_1 buys 4 items and pays \$28. If agent a_2 who has \$3 cooperates with a_1, total budget is \$33. Agents a_1 and a_2 buy 11 items and pay for \$33. We assume that item's price, where the item is sold to end-users, is \$10. Range of side payment is $0 \leq s_1 \leq 4$ per one item.

Agent a_1 is the proposing agent. There are n agents in purchasing community. In this condition, g_1 are sold by $g^1_{1,1}$. The item is discounted step-by-step like a $\{g^1_{1,1}, g^2_{1,1}, ..., g^k_0 1, 1\}$ by quantity which it is sold. $g^k_{1,1}$ shows that g_1 is sold the cheapest by agent a_1. This time, number of l group $T_{\{1,...,2,...,l\}}$ exists by depending probability. All participators reside it. In this case, groups $T_{\{1,...,2,...,l\}}$ have participation probability $f_{\{1,2,...,l\}}(s_i)$ depending on side payment. Now, proposer anticipates that if cooperator of n person are gathered, budget is satisfied.

$$n = \sum_{l=1}^{l} f(s_i) \cdot T_l$$

It is possible to calculate the number of agents shown as this formula. The proposing agent uses this formula and decides a value of side payment. Proposer gathers budgets from cooperators and buys g_1 with volume discount. After that, he/she allocates the item by cooperator's investments. Proposer's utility is shown as $p_{i,j} - g^k_{i,j}$. In a case of individual purchasing, $U' = p_{i,j} - g^1_{i,j}$. He/she allocates side payment $s_i * (U - U')$ to cooperators by investments.

4 Optimization of side payment

It is very important to decide the value of side payment. Cooperator depends on values of side

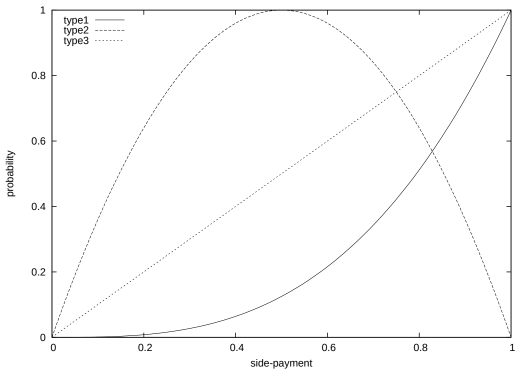

Figure 5. Degree of dependence

payment. Here, we set up a assumption concerned with types of cooperative agents' preferences.

Assumption 4. Proposer knows participation probability.

A proposer can optimize a value of side payment adopting this assumption. When he/she decides value of joint capital G, he/she decides side payment with degree of dependence.

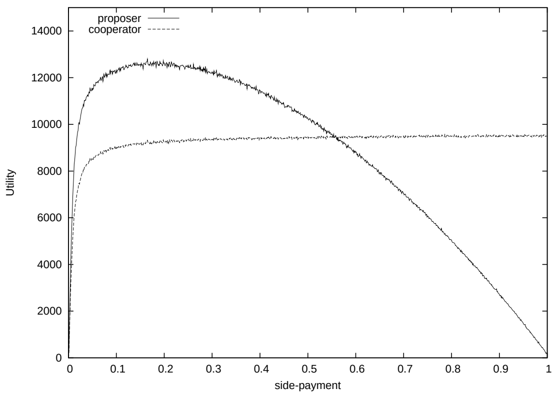

Figure 6. Average of traders' utilities

We consider that the multiple agents who have different degree of dependence exists. A proposing agent knows each group's participation probability when the agent increases side payment among $0.0 \leq s \leq 1.0$. By this probability, the proposer decides values of side payments. Figure 5 shows participation probability of each group. Type 1 is a group of agents who has preference which is participation probability rising nonlinearity. Type 2 is a group who has incentive to participate near 0.5. Type 3 is agents who have participation probability rising

side payment	proposer($)	cooperator($)
0.0	139	0
0.1	12326	9015
0.2	12631	9281
0.3	12249	9364
0.4	11435	9424
0.5	10274	9478
0.6	8800	9413
0.7	7051	9500
0.8	5054	9482
0.9	2513	9552
1.0	155	9486

Table 3. Average of traders' utilities

linearity. If the value of side payment grows, the cooperator gets less side payment. When the value of side payment is just 0.5, agents who are classified in type 2 participate in cooperation. Table 3 shows concrete values of agents' utilities. Each agent has budget between $20,000 and $200,000. We set up his/her budget based on uniform distribution. Figure 6 shows a visual comparison between proposer's and cooperator's utilities. In figure 6, cooperator's utility comes back proposer's utility when investment between 0.5 to 0.6. In this result, the best value of side payment is among $0.0 \leq s \leq 0.6$.

5 Related works

In this section, we present an overview of the work of others related to our research.

GroupBuyAuction[7] is an agent based electronic market on which agents automatically negotiate with each other on behalf of their users. In particular,buyer agents can form coalitions to buy items at a volume discount price. Li and Sycara[8] considered an electronic market where each buyer places a bid on a combination of items with a reservation prices, and sellers offer price discounts for each item based on volumes. By artificially dividing the reservation price of each buyer among the items, optimal coalitions with respect to each item are constructed. These coalitions satisfy the complementarily of the items by reservation price transfars, and include the optimal solution.

Layton-Brown proposes *BiddingClubs*[2]. In a *BiddingClub*, agents conduct a "pre-auction". After the "pre-auction", monetary transfers take place. The *BiddingClubs* show that collusion is still true when multiple auctions take place for substituable items, as well as for complementary items.

Matsuo-Tokuro proposes a new pooled buying method[5]. This method based on risk management and volume discount. The degree of risk is caluclated. Agent cooperate to the proposing agent based on the degree of risk. For risk aversion and promoting cooperation, Matsuo employs the side-payment policy,this is, cooperative agents' risks are preserved to a minimum.

6 Conclusion

This paper shows mechanism of the dealing, negotiation and cooperation promotion. We defined side payment to increase incentives of cooperations. We hypothecated that probability of cooperation participation depends on side payment. Our future work includes decision method of the best side payment without assumption 4.

References

[1] Tokuro Matsuo and Takayuki Ito. A decision support system for group buying based on buyers' preferences in electronic commerce. *In the proceedings of the Eleventh World Wide Web International Conference (WWW-2002)*, pages 84–89, 2002.

[2] Kevin Leyton-Brown, Yoav Shoham, and Moshe Tennenholtz. Bidding clubs: institutionalized collusion in auctions. *ACM Conference on Electronic Commerce*, pages 253–259, 2000.

[3] Kzunori Fujimoto. Decision support for internet users and related work. *Proceedings of the IEICE General Conference*, pages 21–22, 2004.

[4] Kato Naotaka, Chujo Masanobu, and Kunifuji Susumu. A development of a group decision support system facilitating the consensus-making process. *Transactions of Information Processing Society of Japan*, 38(12):2629–2639, 1997.

[5] Tokuro Matsuo. A new pooled buying method based on risk management. *IEA/AIE 2007,LNAI 4570*, pages 953–962, 2007.

[6] E.Turban, J.Lee, D.King, and M.Chung. *Electronic Commerce:A Managerial Perspective*. Pearson Education, 2000.

[7] J. Yamamoto and K. Sycara. A stable and efficient buyer coalition formation scheme for e-marketplaces. *Proceedings of the fifth international conference on Autonomous agents*, pages 576–583, 2001.

[8] C. Li and K. Sycara. Algorithm for combinatorial coalition formation and payoff division in an electronic marketplace. *Proceedings of the first international joint conference on Autonomous agents and multiagent systems: part 1*, pages 120–127, 2002.