Moneymakers and Bartering in Online Games

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Abstract. We study the interpersonal trade network from a Massively Multiplayer Online Role-Playing Game (MMORPG), where players actively engage in the exchange and sales of goods and items in a hyperrealistic virtual environment. In this paper we introduce the concept of Standard Price (SP) of items computed from the trade network, which allows us to investigate the relation between the profitability of a trade and the structure of the social networks of the users. We find that the social network is correlated with the outcome of interpersonal trades. For instance, we observe that the margin of profit in a trade correlates with the social distance between trading partners, suggesting that social affinity implies shared information on the value of an item.

1 Introduction

The economic activity is one of the most common and fundamental activities in the human society. The price at which a good gets sold and bought, marked in a common currency of a market, depends upon a wide range of factors including the scarcity of the goods [1], the nature of the distribution channel [2], the relationship between the seller and the buyer [3], to name a few. The complex combination of these variables can cause identical items to be traded at different prices, resulting in the differentiation of profit margins for those involved in the trade. Recently, the characteristics of the complex network of trading partners and their implication on the market structures and dynamics have garnered much interest [4].

In this paper, we study the relationship between the profit generated in a trade and the social network structure of those involved in it. We utilize the economic

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trade and social interaction records from AION, a Massively Multiplayer Online Role-Playing Game (MMORPG) serviced globally. As the goal of MMORPGs is to provide the gamers with a fantastical yet highly lifelike online environment in which they can form social relations and perform realistic actions, they are gaining popularity as "virtual laboratories" for observing human behavior in great detail [5–11].

In collaboration with NC Soft, Inc., the global service provider of AION, we studied the economic trade and the social network data involving more than 50,000 individuals. By introducing the concept of **Standardized Price (SP)** of bartered items, we determined the monetary value of each item, which allowed us to easily quantify the profit or loss that each individual incurred in a barter for universal comparison.

2 Materials and Methodology

We utilized AION data collected during a span of 87 days between April and July of 2010, comprising nearly 1.7 million interactions between 52,757 anonymized players. For our study we considered the following five interaction types, three economic and two social:

1. **Barter** (economic) accounts for 35.6% of all economic transactions. In a barter two players exchange goods for other goods or the in-game currency "Kinah".
2. **Personal Shop** (economic) accounts for 2.7% of all economic transactions. Here a player buys goods from another player who is in a dedicated "merchant mode," functioning only as a shop owner.
3. **Sales Agency** (economic) accounts for 61.7% of all economic transactions. Here a player buys goods from sales agents controlled by the computer acting on behalf of the owners of the goods.
4. **Friendship** (social) indicates that two players have each other on their Friend Lists.
5. **Private Messaging** (social) indicates that two players have communicated with each other.

2.1 Network Measures

We measure the following network properties from AION:

1. The **degree** k of a player is the number of his neighbors. In a directed network one has the **in-degree** k^{in} and the **out-degree** k^{out}. A **weighted edge** is an edge with an attached value, e.g. the number of transactions between two players.
2. The **geodesic distance** the length of the shortest path joining two players. The **diameter** of a network is the length of the longest geodesic in the network.
3. The **clustering coefficient** C is the probability that two neighbors of a player are themselves neighbors [12, 13].

2.2 The Standard Price of Goods

Barter in AION comprise both monetary non-monetary transactions between players. Cases where items are traded for items pose a particular challenge, as it is difficult to quantify the value of items involved in the network and therefore determine whether one player has made a "profit." Thus we introduce the concept of the "Standard Price (SP)" of an item (in the unit of Kinah, the in-game currency), to be determined from the transaction network itself. The fundamental idea is that an item's value can be computed from those of other items for which it has been traded. One may set up this problem as solving a system of linear equations but this is unlikely to work, as some equations may simply be contradictory (e.g. when an item has been sold once for 500 Kinahs and another time for 1000 Kinahs). Thus we propose the following method. We start by identifying the items that have been traded for Kinah only at least once. Then we set their prices as the average of the Kinahs they were paid for, which we now use to determine the prices of other items that have been traded for Kinah and the first set of items. We can view the prices as propagating through the network via this iteration. Formally, let us denote by s_x the SP of an item x. We can then represent a barter between two players as

$$\{(n_1,s_1),(n_2,s_2),\ldots\} \longleftrightarrow \{(n_a,s_a),(n_b,s_b),\ldots\}, \tag{1}$$

meaning that one player hands to the other player n_1 of item 1 whose SP is s_1, n_2 of item 2 whose SP is s_2, and so forth, in exchange for n_a of item a whose SP is s_a, and so forth. Here we mark a known SP with an asterisk, e.g. s_i^*. The SP of Kinah is its nominal value.

1. Find the transactions that involve only *one* item with the undetermined SP, say item 1 in the barter transaction

$$\{(n_1,s_1),(n_2,s_2^*),\ldots\} \longleftrightarrow \{(n_a,s_a^*),(n_b,s_b^*),\ldots\}, \tag{2}$$

Table 1 Basic network characteristics of AION in comparisons with other online games

Networks	AION			Pardus		
	Trade	PM(9 days)	Friendship	Trade	PM	Friendship
Nodes	21,417	21,771	30,002	18,589	5,877	4,313
Edges	31,539	219,922	100,476	568,923	107,448	21,118
Diameter	23	14	15	NA	NA	NA
Clustering Coefficient / Ratio to Random Network	0.12/872.57	0.04/43.10	0.12/537.50	0.25/109.52	0.28/45.71	0.43/131.95
Average Degree	2.95	20.20	6.70	61.21	36.57	9.79
Average Weighted Degree	6.13	234.00	NA	NA	NA	NA

* measurements of Pardus is from Szell *et al.*'s paper. [8]

from which s_1^* is given as

$$s_1^* = \frac{(n_a s_a^* + n_b s_b^* \cdots) - (n_2 s_2^* + n_3 s_3^* + \cdots)}{n_1}. \tag{3}$$

Perform a similar calculation for all such transactions.

2. Substitute the newly determined SP's for the same items in all the remaining transactions.
3. Repeat.[1]

The SP's of items determined using this method can now be used to quantify the profit incurred by player i in a barter with player j, as

$$R_{ij} = -\Big(\sum_i n_i s_i^*\Big) + \Big(\sum_j n_j s_j^*\Big), \tag{4}$$

where $R_{ij} = -R_{ji}$, and $\sum_i$ is the summation over the items given by i to j, and vice versa. A negative R_{ij} would mean that player i has made a loss (and j a profit).

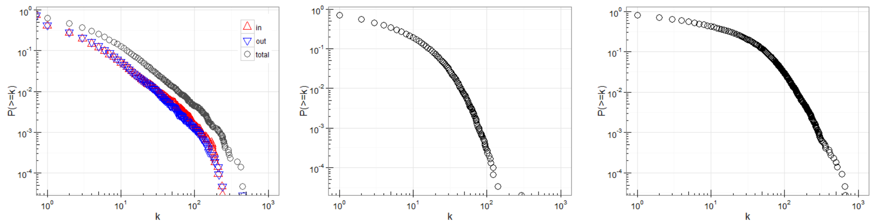
3 Results

3.1 Basic Network Characteristics

In Table 1 we present the basic properties of networks in AION, along with those of networks from another online game Pardus [8] for comparison. The networks from AION exhibit the so-called "small-world" property (with the diameter being much smaller than the network size), while the Barter and the Friendship network also exhibit high clustering typical of social networks, although the Private Messaging does not, presumably due to the fact that one can send messages freely to anyone on the game. While networks from Pardus generally show higher clustering, the two networks from AION exhibit a larger ratio against the randomized value, possibly resulting from the fact that gameplay in AION are centered around communities called a "Legion." [7]

The cumulative degree distributions are given in Fig. 1. The Barter network is a weighted directed network; the in-degree k^{in} of a node is the number of money-making (profitable) barters, while the out-degree k^{out} is that of lossmaking barters. Friendship and Private Messaging (PM) networks are considered undirected and simple.

[1] For the undetermined s's that remained when the method could no longer be applied, we assumed they were the same price $\tilde{s}$ and solved for it from the linear equation. As they were very few in number and were thus highly likely to be insignificant.



(a) Barter **(b)** Friendship **(c)** Private Messaging

Fig. 1 The cumulative degree distributions of networks in AION. The Barter network is weighted and directed, with the in-degree k^{in} defined as the number of profitable transactions, and the out-degree k^{out} defined as that of lossmaking transactions. The Friendship and the Private Messaging (PM) networks are considered undirected and simple.

3.2 Profits and the Social Network

In Fig. 2 we show the distribution of net (total) profits of the players based on the SPs calculated using the method above . An intriguing aspect of it is the nearly even split between the “moneymakers” and the “losers”, signified by the two peaks on the negative and the positive sides of the *x*-axis. The near perfect symmetry between the peaks reflects the skewed degree distribution of Fig. 1 (a), where a majority of people conducted one transaction so that for each profit a matching loss exists.

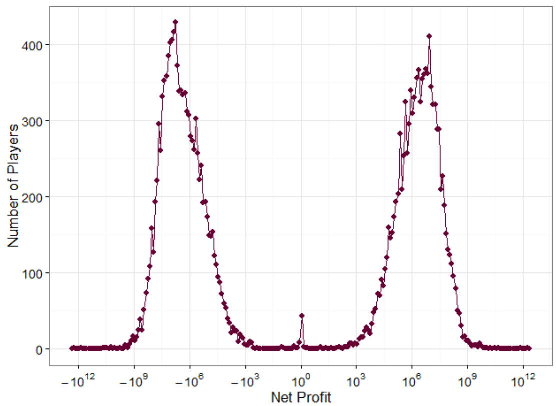


Fig. 2 The distribution of the overall net profits for players who engaged in barter with other players. Interestingly, there exists a split between moneymakers and losers, indicated by the two prominent peaks.

3.2.1 Degree and Profits

Given that the nodes of a network are primarily characterized by their degrees [14], it is interesting to see whether there exists a relationship between the nodes' profits and degrees.

First, presuming that one's skill in deal making increases with one's experience, we can inspect whether one's net profit correlates with the degree itself, i.e. the number of transactions one was involved in. The correlation between degree and net profit turns out to be, however, insignificant: the Pearson correlation coefficient is 0.01 ± 0.02, demonstrating that simply making many trades with others is no indication of good skills[2].

Second, based on the previous realization that a high degree does not necessarily mean a high level of profit, we can ask whether we can distinguish between those who make profits with a high probability and those who do not, given the degree. Indicating the direction of the flow of profit by the direction of the edge in a network (therefore, a player's out-degree is the number of transactions from which the player has suffered a loss), we studied the Pearson correlation coefficient between the in- and out-degrees of the nodes, which turned out to be 0.66 ± 0.09. This means that those with many profitable trades also have many loss-making trades.

These two findings suggest that the degree is generally a poor indicator of profitability in barter, and therefore we may need to investigate other higher-order network properties to understand the nature of the profits better.

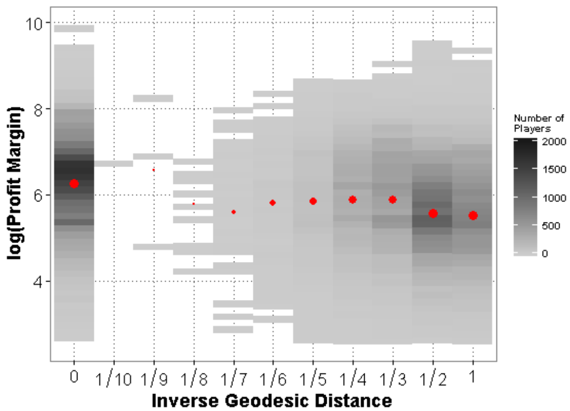


Fig. 3 The profit margin in a trade versus the social distance between the partners in the trade. The red dots represent the average for each inverse distance value. The profit margin generally correlates positively with distance, indicating relative lack of common belief or knowledge about the value of an item between players who are far apart.

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[2] To avoid problems from extremely high values, we took the logarithm of the profits in the calculation.

3.2.2 Profitability, Trade Frequency, and Social Network Distance

As mentioned above, an important feature of a network is the concept of the "distance" between nodes. We studied whether there exists a correlation between the profitability (profit margin) of a trade and the social distance between the trading players; from the Friendship network of AION we determined the geodesic distance between the players, and found a Pearson coefficient of -0.25 ± 0.01 between the (logarithmic) profit margin and the inverse geodesic distance[3], implying that the further apart two players are socially, the higher the profit margin and the likelihood of trade to become less "fair." This is a result that strongly suggests the existence of a network effect in assessment of the value of an item in a trade, i.e. an implicitly "shared knowledge" between users that are close in the network.

4 Conclusion

Online gaming environments act as a virtual laboratory in which one can examine detailed socioeconomic behaviors of players, creating interesting opportunities for research. In this paper we analyzed the relationship between the social networks of people and their economic trade behaviors. We found out that a person's profitability is not correlated with their frequency of trade or experience, and that the social distance increased the profit margin, i.e. social affinity lowered the profit margin, indicating some possible role that a social network plays in economic activities.

We believe that our work, along with our method for determining the Standard Price of items from barter data in MMORPGs, lays the foundation for a more in-depth study on the relationship between economic activities and social networks in online environments. We plan to investigate this further, as there are undoubtably many more quantifiable properties of the players' social networks that correlate with their trade behaviors. We also believe that our work has the potential to shed light on the social network-related dynamics of markets in the real world as well.

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