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A Modelling of the Role of Social Networks in Market Mechanism - Social Ties as Screening Tools in Price Discrimination

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Abstract

One of the most relevant and exciting issues in the latest decades in economics had been the asymmetric information and uncertainty, and their effects on market processes and efficiency. Some studies show that markets where information problems or/and uncertainty arise tend to be "networked", and some studies propose that use of social networks can mitigate adverse selection and moral hazard problems, but this area is still under-developed. Price discrimination is a representative situation where asymmetric information vigorously appears. The firms rarely have precise information about the types of individual customers (their important features, preferences or willingness-to-pay), but can use incentive tools and screening mechanisms. Use of signaling and screening can reduce the cost of incentive under asymmetric information. We develop a model to show that social embeddedness of buyers and some relevant features of their social network can be used for screening to mitigate the information problem in pricing decisions.

JEL: D8, L11, Z13.

KEYWORDS: asymmetric information, nonlinear pricing, incentive contracts, social network, social embeddedness.

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A kapcsolati háló piaci mechanizmusokban betöltött szerepének egy modellje – Társas kapcsolatok mint szűrőeszközök az árdiszkriminációban

Kiss Károly Miklós – Edőcs Kinga

Összefoglaló

A közgazdaságtanban az utóbbi évtizedek egyik igen fontos és izgalmas kérdésköre az aszimmetrikus információ és a bizonytalanság és hatásuk a piaci folyamatokra és hatékonyságra. Néhány tanulmány megmutatja, hogy azon piacok, amelyeken információs problémák és/vagy bizonytalanság merül fel, hajlamosak a „hálózatosodásra". Néhány tanulmány felveti, hogy a kapcsolati háló felhasználható a kontraszelekciós és erkölcsi kockázati problémák csökkentésére, azonban e terület még nem kellően kutatott. Az árdiszkrimináció az egyik olyan terület, ahol az aszimmetrikus információ problémája erőteljesen jelentkezik. A vállalatoknak ritkán vannak pontos információik az egyes fogyasztók típusáról (fontosabb jellemzőiről, mint preferenciáik vagy fizetési hajlandóságuk), de használhatnak ösztönző eszközöket és szűrő mechanizmusokat. A jelzés és szűrés eszközei csökkenthetik az aszimmetrikus információ esetén szükséges ösztönzés költségeit. Ebben a tanulmányban egy olyan modellt írunk fel, amelyben bemutatjuk, hogy a vásárlók társadalmi beágyazottsága és a kapcsolati hálójuk bizonyos releváns jellemzője szűrőeszközként használható az árazási döntésekben megjelenő információs probléma mérséklésére.

JEL: D8, L11, Z13

Tárgyszavak: aszimmetrikus információ, nemlineáris árképzés, ösztönző szerződés, kapcsolati háló, társadalmi beágyazódás

1. INTRODUCTION

In several markets the important features of goods, the quality and reliability are less predictable, and these markets often operate through social and business networks or through networked interactions. Some studies show that markets where information problems or/and uncertainty arise tend to be "networked" – in the sense that market participants fundamentally build upon their social and business ties.

Although the phenomenon is not new, but the spread of social and business networks and an extensive application of these relationships in many types of interactions are more and more perceptible in modern societies and in economic systems. It is becoming increasingly typical that firms tend to form and maintain close partnerships and supplier relationships. Market participants often search information and products or services in their social networks (e.g. exchange of second-hand commodities, job-seeking, searching information of consumer experiences, etc.). Firms also use the customer's social ties in many marketing techniques more and more intensively. An important reason of "networking" of the economic and business interactions is that application of these relationships can mitigate information problems.

Several empirical studies demonstrate that those markets tend to be networked where the problems derived from uncertainty an asymmetric information are significant that is, long-term ties of buyers and sellers evolve in such markets. (See, e.g. the case of the apparel industry: Uzzi

(1996), Marseille fish market Kirman (2001) and Weisbuch, Kirman, and Herreiner (2000), investment banking Podolny, J.M. (1994)). According to these studies, the role of social and business networks was intensified where larger uncertainty and the lack of other tools of managing uncertainty characterize the market transactions. Uzzi (1996) argues in his analysis of supplier partnerships in the apparel industry that firms set a high value on close and long-term partnerships with their suppliers that are characterized by mutual trust, regular and effective information flow, and collective solution searching. He finds a positive and significant relationship between firms' survival and the embeddedness of companies, i.e., the number of their close partnership ties. These networks are able to alleviate the effects of uncertainty and information problems by means of creating trust and a more effective access to information.

The role of information in economic decisions as well as the phenomena and consequences of incomplete knowledge and information asymmetry was studied since the 1970's in the literature of the economics of information (e.g., Akerlof (1970), Kahneman and Tversky (1979), Stiglitz and Weiss (1981), Grossman and Hart (1983), Fudenberg and Tirole (1990), Laffont and Meleu (1997), Dewatripont, Jewitt and Tirole (1999), and Stiglitz (2000)). Further useful points of departure in the literature on asymmetric information that we will rely on are: Grossman and Hart (1983), Milgrom and Roberts (1992), Laffont and Tirole (1993), Fudenberg and Tirole (2000), just as the essential book on incentive-theory by Laffont and Martimort (2002).

The literature on information asymmetry demonstrates that in case the parties in a market interaction have different information on important features of the subject of transaction (of a product or service) or on each other's behavior and effort, then this information problem may distort the decisions and can cause market failures. The market outcomes under these information problems can be improved by the various tools of screening and signaling (Spence, 1973).

The use of social and business networks can be an effective tool for diminishing the problems of adverse selection and moral hazard under asymmetric information. These networks take effects through three different mechanisms.

First, these networks can ameliorate the problems of uncertainty and information asymmetry because the persistent interactions repeated through reliable, long-term relationships ensure sufficient incentives. This was observed by Uzzi (1996) in his study on close supplier relationships: long-term partnerships reduce the risk of bad quality or inefficient operation, because these options will become less rewarding in repeated transactions.

Secondly, the chance of obtaining information is bigger in close social and business networks: the parties in a network might get more and/or more correct and reliable information. The use of reliable relationships can improve the access to information and its reliability, too. To study this issue, we need to examine the features of networks as well. The efficiency of information flow in a network is influenced by the structure of both the whole network and the 'ego network' of each participant.

Thirdly, the social network can be used as a tool of screening by the underinformed party. If the social and business ties have the property of homophily, which means that the probability of forming links between similar agents is higher, then these characteristics can be used to separate the different types of market players.

Hence, the embeddedness in social networks can be used to mitigate the consequences of asymmetric information. This is applied in the case of microfinance techniques and peer-to-peer lending in loan markets, in job referrals used in recruitment, or in corporate marketing techniques to identify and align different types of buyers (consumers with different willingness-to-pay).

Although our model refers explicitly to the case of price discrimination but the conclusions we draw can be generalized and can be applied to several situation where asymmetric information appears and social network has important role such as job-seeking in labor markets, micro-finance groups, online peer-to-peer lending and other online peer-to-peer markets.

The structure of the paper is as follows: In the section 2 we review the importance of social ties and homophily in price discrimination. We outline the modelling assumptions in section 3. Then we describe the model of price discrimination with two different consumer types in section 4. Interpretation of results of the model is discussed in section 5.

2. THE ROLE OF HOMOPHILY IN MARKET DECISIONS UNDER INFORMATION PROBLEMS

There are several examples of market situations where asymmetric information appears and social network has important role such as labor markets, micro-finance groups, online peer-to-peer lending or other online peer-to-peer markets, and price discrimination. We built upon the phenomena of homophily. Several studies show that among other things, education, occupation and social class can be one source of homophily in social networks. Thus we can assume that social ties of various types of buyers show some degree of homophily. The buyers' willingness to pay are related to their socio-economic characteristics (their financial situation, income, savings and some other features).

Lazarsfeld and Merton (1954) created the word „homophily", that is „love of the same" (homo=self, philia=love) for the inclination of individuals to associate others who are similar to them. McPherson, Smith-Lovin and Cook (2001) presented an overview of studies about different origin of homophily. It applies very broadly, as measured by age, gender, race, religion in several different studies. There are several studies which have demonstrated empirically homophily has an important factor in the formation and differentiation of social groups (Lazarsfeld and Merton 1954; Laumann 1966; Fischer 1977; Verbrugge 1977; McPherson and Smith-Lovin 1987; Marsden 1988; Burt 1991; Popielarz

and McPherson 1995, McPherson, Smith-Lovin and Cook 2001). Education, occupation and social class is also one source of homophily. Strong educational homophily was found in informational flows (Schneider et al 1997) and in the cooperative links between community organizations (Galaskiewicz and Shatin 1981). Social classes (according to property, skills or intelligence) determine the friendship relations (Wright 1997). Some papers have exhibited that people tend to interact with others who have similar cultural background, that is, status homophily exists (Lazarsfeld and Merton 1954; Fischer 1977; Marsden 1987, 1988; Shrum, Cheek, and Hunter 1988).

Building upon the homophily emerging in buyers' social ties we developed a model of price discrimination. We apply a basic principal-agent model based on Laffont and Martimort (2002) to describe price discrimination under asymmetric information, where the social structure is grabbed by the probability distribution of ties.

3. THE MODEL: ASSUMPTIONS

The following assumptions are made on firms and buyers. First, we keep to the common assumption in economics that the firms and the buyers both adopt an optimizing behavior and maximize their individual utility. We also assume that customers and firms are risk neutral.

THE FIRM

For simplicity, we assume that only one firm sells a product with no close substitutes. This monopoly situation allows us to concentrate on the main issue without having to deal with the technicalities of interactions and strategic behavior of firms in competitive situations.

The firm produces a single product at constant marginal cost *(c)*. The company uses nonlinear pricing, it designs menus or bundles: each consisting of a quantity (or quality[1]) package of the good and a total payment for this quantity package. Thus the firm faces the problem of offering the right menus (quantity (or quality) – tariff pairs) to the different types of customers. Let $\mathcal{A}$ be the set of menus. Formally, the company should offer $\mathcal{A} = \{(q, t)\}$, menus (a given quantity q for a given tariff t) where $q \in R_+, t \in R_+$.

The firm's profit earned on each buyer (or on a menu) is

[1] The parameter *q* can also be interpreted as a quality parameter so the firm designs various quality packages of the goods for the different types of buyers (such as various classes of seats on flights offered by airlines).

$$\pi(q_i, t_i) = t_i - c(q_i) \quad (1)$$

BUYERS

The buyers vary in their reservation price or willingness to pay. For the sake of simplicity, we assume that there are only two different types of customer on the market: buyers with high willingness to pay and buyers with low willingness to pay. This discrete type model is sufficient to set up the main phenomena arising in this market situation without having to deal with the technical difficulties of a continuum of types. (We use subscripts to label low willingness-to-pay buyers *(l)* and high willingness-to-pay buyers *(h)*).

A buyer of type *i* has preferences (tastes) by the utility function:

$$U_i(q_i, t_i) = \theta_i u(q_i) - t_i \quad (2)$$

where q is the quantity consumed and t is her payment to the firm, and the parameter θ_i of each buyer measures the difference of their willingness to pay. θ belongs to the set $\Theta = \{\theta_l, \theta_h\}$, where $\theta_l < \theta_h$ (the same quantity q is evaluated higher by a buyer with high willingness to pay than by a low valuation type). The magnitude of uncertainty on the consumer's willingness to pay is denoted by $\Delta\theta = \theta_h - \theta_l > 0$.

SOCIAL STRUCTURE

Let the society of the model consist of N persons, who are divided into two groups: ν proportion of the population is low willingness-to-pay person and $1 - \nu$ proportion is high willingness-to-pay ones. Thus, based on the law of large numbers, the buyers can have either low valuation (θ_l) or high valuation (θ_h) with respective probabilities ν and $1 - \nu$.

Each type of consumers can form social ties with both same types and other types, but we suppose that homophilous behavior characterizes them , i.e., each valuation type of buyers tend to form more same-type ties and fewer other-type ties. In other words, the probabilities of forming same-type and other-type ties are different. Suppose that if a high willingness-to-pay consumer "meets" a same-type person, the probability of forming a social tie between them is η_{hh}, and if she or he meets a low valuation person, the probability of forming a social tie between them let be η_{hl}, where $\eta_{hh} > \eta_{hl}$ (owing to the homophily). Similarly, the probabilities of forming same-type and other-type social ties by a low valuation person let be η_{ll} and η_{lh}, respectively (where similarly $\eta_{ll} > \eta_{lh}$ due to the

homophily). For the sake of further simplicity and clarity, we introduce two assumptions. First, we assume that the probabilities of forming tie when any consumer "meets" same-type person (η_{ii}) are the same, that is, $\eta_{hh} = \eta_{ll} = \eta_{same}$ and, in the same way, the probabilities (η_{ij}) of forming other-type ties are also equals, that is, $\eta_{hl} = \eta_{lh} = \eta_{diff}$. Second, let us assume that $\eta_{same} = 1 - \eta_{diff} > \frac{1}{2}$. (This is just a technical simplification to simplify the notations and equations: $\eta_{hh} = \eta_{ll} = \eta_{same} = \eta$ and $\eta_{hl} = \eta_{lh} = \eta_{diff} = 1 - \eta$, where $\eta > \frac{1}{2}$.

Since the probability of picking a high valuation type from our simple two-type "society" is $1 - \nu$, the overall probability of forming a same-type social tie by a high willingness-to-pay consumer is the product of these probabilities: $(1 - \nu)\eta$. The overall probabilities of other cases can be deduced similarly. Summarizing these probabilities:

- probability of forming a same-type social tie by a high willingness-to-pay consumer is $(1 - \nu)\eta$
- probability of forming a same-type social tie by a low willingness-to-pay consumer is $\nu\eta$
- probability of forming an other-type social tie by a high willingness-to-pay consumer is $\nu(1 - \eta)$
- probability of forming an other-type social tie by a low willingness-to-pay consumer is $(1 - \nu)(1 - \eta)$
- where $\eta > \frac{1}{2}$ (due to the homophily).

INFORMATION STRUCTURE AND TIMING

The firm does not know (cannot observe) the type (willingness to pay) of each new buyer. The new buyers can have either low valuation (θ_l) or high valuation (θ_h) with respective probabilities ν and $1 - \nu$, and the probability distribution of this information is common knowledge. What is important for us that there exists an objective distribution for the possible types of the buyers that is known by the firm. The firm moves first (it offers a contract menu) anticipating the buyers' subsequent behavior and optimizing accordingly

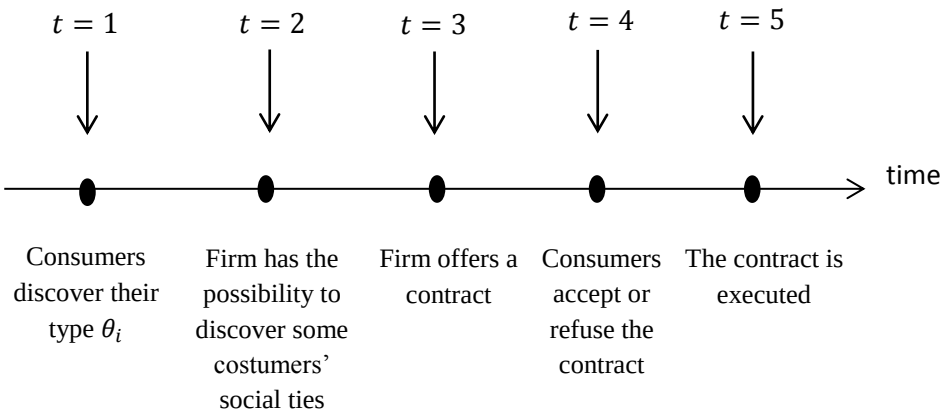
within the set of available contracts. But before optimizing the contract menu the firm has the chance to discover some of its former buyers' social ties (whose type become unrevealed in former transactions: for example by using social media or by the former buyers' referrals (by a referral program)). Thus the firm has the opportunity to use this information during optimization of nonlinear pricing menu.

The timing of contracting between the firm and the buyers is as follows:

1. "Nature" settles the distribution of types and consumers recognize their types.
2. The firm can discover some of its former buyers' social ties.
3. The firm offers a contract menu $\{(q_I, t_I)\}$ for each type of new buyers, where "*i*" denotes the buyer's valuation type that can be high or low $(i = h, l)$.
4. Consumers accept or refuse the contract (take the product or leave).
5. Pay-offs occur, players realize their utilities from the transaction.

Figure 1.

Timing of contracting



Since the firm knows only the probability distribution, it is a Bayesian expected utility maximizer. The optimal menus offered to various types of buyers depend on the probability distribution. If the firm knows high and/or low valuation consumers, the firm is able to revise the probability distribution by using the discovered consumers' social ties.

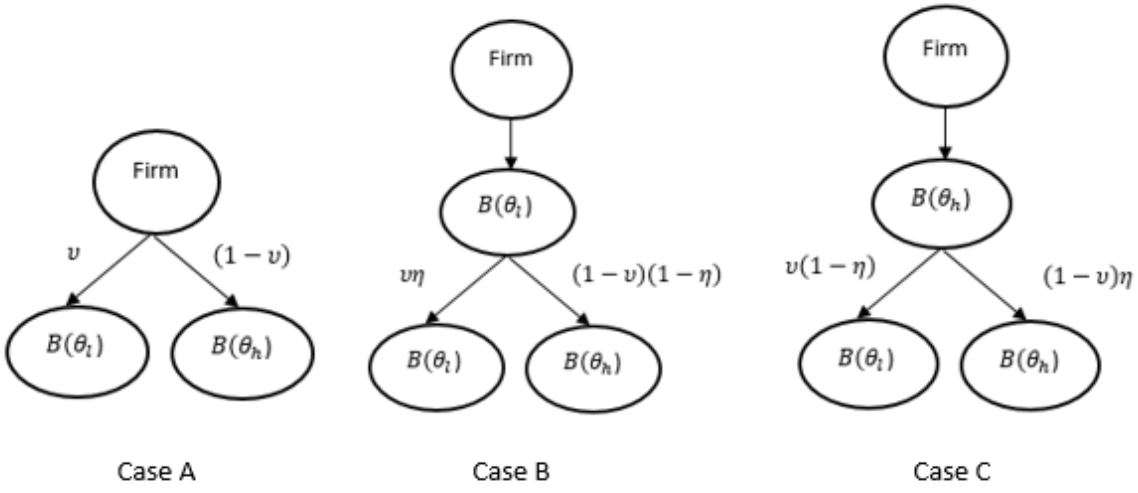
The firm can "reach" each type of consumers on three ways with different probability distributions (the three cases are summarized in figure 2):

Case A: if the firm does not have any information about a potential consumers' social network, the buyer's willingness to pay can be low with probability ν and it can be high with probability $1-\nu$.

Case B: if the firm knows a low valuation consumers and it picks a potential consumer from the known low valuation buyer's social links, the new buyer's willingness to pay can be also low with probability $\nu\eta$ and it can be high with probability $(1-\nu)(1-\eta)$ (based on the probabilities defined above).

Case C: if the firm knows a high valuation consumers and it picks a potential consumer from the known high valuation buyer's social ties, the new buyer's willingness to pay can be also high with probability $(1-\nu)\eta$ and it can be low with probability $\nu(1-\eta)$.

Figure 2.



4. THE MODEL: CONSTRAINS AND OPTIMIZATION PROGRAM OF THE FIRM

Based on the probability distributions, we can describe the firm's optimization program for one new buyer in expected terms. If the probability of being the buyer low valuation type is p (and being high one is *1-p*), the firm's objective function (expected profit function) is:

$$E\pi(q_l, q_h, t_l, t_h) = p[t_l - c(q_l)] + (1-p)[t_h - c(q_h)] \qquad (3)$$

where values of p are defined above in the three cases. But the firm faces some constrains that we have to define: the incentive and participation constraints define the set of incentive feasible allocations. We should optimize the firm's objective function within the set of incentive feasible allocations.

As we described above the customers' utility functions are $U_l(q_l, t_l) = \theta_l u(q_l) - t_l$ and $U_h(q_h, t_h) = \theta_h u(q_h) - t_h$, respectively, that can be translated as the information rent left at the different types of purchasers by the firm.

The participation constraints[2] that must be satisfied are:

$$U_l \geq 0, \text{ that is } \theta_l u(q_l) - t_l \geq 0 \qquad (IR_l)$$

$$U_h \geq 0, \text{ that is } \theta_h u(q_h) - t_h \geq 0 \qquad (IR_h)$$

As far as the customers' willingness to pay is their private information the firm should offer the packages $\{q_l, t_l\}$ and $\{q_h, t_h\}$ such that buyers with low willingness to pay (θ_l) select $\{q_l, t_l\}$ and consumers with high willingness to pay (θ_h) select $\{q_h, t_h\}$. Under asymmetric information we have to make further restrictions on the offered menus, otherwise the high valuation consumer mimics low valuation type and also chooses $\{q_l, t_l\}$, that is, the self-selection doesn't work. These incentive constraints can be expressed by information rents:

$$\theta_l u(q_l) - t_l \geq \theta_l u(q_h) - t_h, \text{ that is } U_l \geq U_h - \Delta\theta u(q_h) \qquad (IC_l)$$

$$\theta_h u(q_h) - t_h \geq \theta_h u(q_l) - t_l, \text{that is } U_h \geq U_l + \Delta\theta u(q_l). \qquad (IC_h)$$

These are the usual participation and incentive compatible constraints used in models of asymmetric information that ensure the consumers should participate and accept the

[2] The utility level of a menu should reach the level of an outside opportunity utility to ensure the consumers will participate and accept the offer.

offer and that they should choose the right contract menu (they should not mimic other type choosing the other menu).

Thus the firms' constrained optimization problem can be written in expected term as:

$$E\pi(q_l, q_h, t_l, t_h) = p[t_l - c(q_l)] + (1-p)[t_h - c(q_h)]$$

subject to IR_l, IR_h, IC_l, IC_h.

Substituting the probabilities of three cases we introduced above into the basic model, the expected profit function and first order conditions are in each case:

Case A

$$E\pi = [\nu(t_l - c(q_l)) + (1-\nu)(t_h - c(q_h))] \quad (4)$$

$$\frac{\delta\pi}{\delta q_l} = \nu[\theta_l u'(q_l) - c'(q_l)] + (1-\nu)[-(\theta_h - \theta_l)u'(q_l)] = 0 \quad (5)$$

$$\frac{\delta\pi}{\delta q_h} = (1-\nu)[\theta_h u'(q_h) - c'(q_h)] = 0 \quad (6)$$

Case B

$$E\pi = [(\eta\nu)(t_l - c(q_l)) + (1-\eta)(1-\nu)(t_h - c(q_h))] \quad (7)$$

$$\frac{\delta\pi}{\delta q_l} = (\eta\nu)[\theta_l u'(q_l) - c'(q_l)] + (1-\eta)(1-\nu)[-(\theta_h - \theta_l)u'(q_l)] = 0 \quad (8)$$

$$\frac{\delta\pi}{\delta q_h} = (1-\eta)(1-\nu)[\theta_h u'(q_h) - c'(q_h)] = 0 \quad (9)$$

Case C

$$E\pi = [\eta(1-\nu)(t_h - c(q_h)) + (1-\eta)\nu\,(t_l - c(q_l))] \quad (10)$$

$$\frac{\delta\pi}{\delta q_l} = (1-\eta)\nu[\theta_l u'(q_l) - c'(q_l)] + \eta(1-\nu)[-(\theta_h - \theta_l)u'(q_l)] = 0 \quad (11)$$

$$\frac{\delta\pi}{\delta q_h} = \eta(1-\nu)[\theta_h u'(q_h) - c'(q_h)] = 0 \quad (12)$$

Rearranging first order conditions, the optimal quantities are determined by the following equations

Case A

$$c'(q_l) = \theta_l u'(q_l) - \frac{1-\nu}{\nu}(\theta_h - \theta_l)u'(q_l) \quad (13)$$

$$c'(q_h) = \theta_h u'(q_h) \tag{14}$$

Case B

$$c'(q_l) = \theta_l u'(q_l) - \frac{(1-\eta)(1-\nu)}{\eta\nu}(\theta_h - \theta_l)u'(q_l) \tag{15}$$

$$c'(q_h) = \theta_h u'(q_h) \tag{16}$$

Case C

$$c'(q_l) = \theta_l u'(q_l) - \frac{\eta(1-\nu)}{(1-\eta)\nu}(\theta_h - \theta_l)u'(q_l) \tag{17}$$

$$c'(q_h) = \theta_h u'(q_h) \tag{18}$$

It means, that the firm has to offer three different menus (with different q_h, q_l and t_h, t_l) to a new potential consumer, depending on the way how the firm is able to reach her/him:

Case A to the buyers whose social network is unknown: $\mathcal{A}^A = \{(q_l^A, t_l^A), (q_h^A, t_h^A)\}$

- where the probability that the new buyer is low valuation type is ν, so downward distortion of the quantity offered to low valuation type is $\frac{1-\nu}{\nu}$.

Case B to the buyers who belong to a former unrevealed low valuation buyer's social network: $\mathcal{A}^B = \{(q_l^B, t_l^B), (q_h^B, t_h^B)\}$

- where the probability that the new buyer is low valuation type is $\eta\nu$, so downward distortion of the quantity offered to low valuation type is $\frac{(\mathbf{1}-\boldsymbol{\nu})(\mathbf{1}-\boldsymbol{\eta})}{\boldsymbol{\nu\eta}}$

Case C to the buyers who belong to a former unrevealed high valuation buyer's social network: $\mathcal{A}^C = \{(q_l^C, t_l^C), (q_h^C, t_h^C)\}$

- where the probability that the new buyer is low valuation type is $\eta(1-\nu)$, so downward distortion of the quantity offered to low valuation type is $\frac{(\mathbf{1}-\boldsymbol{\nu})\boldsymbol{\eta}}{\boldsymbol{\nu}(\mathbf{1}-\boldsymbol{\eta})}$

From (13)-(18), using that under homophily $\eta > \frac{1}{2}$, we can easily see that the relations of parameters of optimal menus in each case are the follows[3]:

$$q_l^C < q_l^A < q_l^B, \tag{19}$$

$$q_h^A = q_h^B = q_h^C, \tag{20}$$

$$t_l^C < t_l^A < t_l^B, \tag{21}$$

$$t_h^C > t_h^A > t_h^B \tag{22}$$

5. INTERPRETATION OF RESULTS OF THE MODEL

As we can see, the firm offers to the high valuation customers that quantity which it would offer in equilibrium without asymmetric information (i.e., when the firm could perfectly detect the valuation type of the buyers)[4], but the low willingness-to-pay buyers are provided less, than under perfect information. There is a downward distortion of the quantity offered to her.

Using the profit maximizing quantities we get

$$t_l = \theta_l u(q_l), \text{ that is, } U_l = 0 \tag{23}$$

$$t_h = \theta_h u(q_h) - (\theta_h - \theta_l)u(q_l), \text{ that is, } U_h = (\theta_h - \theta_l)u(q_l) \tag{24}$$

The high valuation customers can realize some information rent: $(\theta_h - \theta_l)u(q_l)$, and the level of this information rent depends on the quantity offered to the low valuation type buyer. This is the well-known result of principal-agent models. There is an information rent-allocative efficiency trade-off. The downward distortion of low valuation type buyer is rewarding for the firm: the information rent of the high willingness-to-pay buyers reduces

[3] We can also see from the probabilities defined in case B and C that if η is non informative, i.e., there is no homophily ($\eta = 1 - \eta = 1/2$), the optimal menus will be the same in each case ($q_l^A = q_l^B = q_l^C$; $t_l^A = t_l^B = t_l^C$; $q_h^A = q_h^B = q_h^C$; $t_h^A = t_h^B = t_h^C$).

[4] The first equation says that marginal cost is equal to the marginal benefit (utility).

along with the quantity offered to the "low type". And as we can see, the extent of downward output distortion of low valuation type depends on the conditional probability distribution. This is what is important to us here. The lower the probability of encountering low valuation buyer, the more it is rewarding to reduce the quantity offered to her, and then the information rent of the more likely high valuation type will also decrease more. The firm uses social embeddedness of buyers as a screening tool to mitigate the information problem. If social ties of various types of buyers show some degree of homophily then each valuation type of buyers tend to form more same-type ties and fewer other-type ties. If the firm picks a new potential buyer from social network of a previously acquainted high valuation type consumer, then the new buyer will also be more likely to have high willingness-to-pay and less likely to have low willingness-to-pay. Similarly, if the firm picks a new potential buyer from social network of a previously acquainted low valuation type consumer, then the new buyer will also be more likely to have low willingness-to-pay and less likely to have high willingness-to-pay. The probability of low type buyer is the lowest in Case C (when the firm picks a new potential buyers form a known high valuation consumer's social ties) and the highest in Case A (when the firm picks a new potential buyers form a known low valuation consumer's social ties). That is, the firm needs to reduce the quantity offered to low valuation type buyer most in Case C, and least in Case A (as we can see in optimal quantities of (19)). Thus the information rent the firm has to leave at high valuation type can be smaller in Case C, than in other cases, when the probabilities of low valuation type buyer is higher (as we can see in (22)). We also can see from the first order conditions of profit maximizing menus, (13), (15) and (17), that the degree of downward distortion of quantity offered to low valuation type buyer also depends on the magnitude of uncertainty on the consumer's willingness to pay, $(\theta_h - \theta_l)$. The greater the magnitude of this uncertainty (the difference between the valuation of various type buyers), the more it is worth decreasing the quantity offered to low willingness-to-pay buyers.

We presented in this formalized model that building upon the formerly unrevealed buyers' social ties the firm is able to separate the different types of buyers more precisely, thus it can design more profitable system of menus of price discrimination.

REFERENCES

Akerlof, G. (1970), *The Market for 'Lemons': Quality Uncertainty and the Market Mechanism*. Quarterly Journal of Economics, 84 (3), 488–500.

Burt, R. S. (1991). *Age as a Structural Concept*. Social Networks 19:355–73.

Dewatripont, M. – Jewitt, I. – Tirole, J. (1999), *The Economics of Career Concerns, Part I: Comparing Information Structures*. Review of Economic Studies, 1999, vol. 66, issue 1, 183-198.

Fischer, C. S. (1977). *Networks and places: Social relations in the urban setting*. New York: Free Press

Fudenberg, D. és J. Tirole (1990), *Moral hazard and renegotiation in agency contracts*. Econometrica: Journal of the Econometric Society, 1279-1319

Fudenberg, D. és J. Tirole (2000), *Customer poaching and brand switching*, RAND Journal of Economics, 2000, 31 (4), 634–657.

Galaskiewicz J, Shatin D. (1981), *Leadership and networking among neighborhood human service organizations*. Admin. Sci. Q. 26:434–48

Grossman, S. J. és O. D. Hart (1983), *An Analysis of the principal-Agent Problem*. Econometrica, 51, 7–45.

Kahneman, D – Tversky, A. (1979), *Prospect Theory: An Analysis of Decision under Risk*. Econometrica, Vol. 47, No. 2 1979, 263-291.

Kirman, A.P. (2001), Market Organization and Individual Behavior: Evidence from Fish Markets, in Rauch, J. and A. Cassella, editors, Networks and Markets, Russell Sage Foundation: NY.

Laffont, J-J. and Martimort, D. (2002), *The Theory of Incentives*. Princeton Univ. Press. Princeton.

Laffont J,-J. and Meleu, M. (1997), *Reciprocal Supervision, Collusion and Organizational Design*. The Scandinavian Journal of Economics, Vol. 99, Issue 4, 1997. 519–540.

Laffont, J,-J. – Tirole, J. (1993), A Theory of Incentives in Procurement and Regulation, Cambridge, MA: The MIT Press.

Laumann, E. O. (1966), *Prestige and Association in an Urban Community*. Indianapolis: Bobbs-Merrill.

Lazarsfeld, P.F, and Merton, R.K. (1954). *Friendship as a social process: a substantive and methodological analysis, in Freedom and Control in Modern Society*, ed. M Berger, 18-66, New York: Van Nostrand

Marsden, P. V. (1987), *Core Discussion Networks of Americans*. *American Sociological Review* 52:122–313.

Marsden, P. V. (1988). *Homogeneity in Confiding Relations*. *Social Networks* 10:57–76.

McPherson, M., and Smith-Lovin, L. (1987). *Homophily in Voluntary Organizations: Status Distance and the Composition of Face-to-Face Groups*. *American Sociological Review* 52:370–79.

McPherson, M., Smith-Lovin, L. and Cook, J.M. (2001), *Birds of a Feather: Homophily in Social Networks*. Annu. Rev. Sociol., 27, 415-44

Milgrom, P. és J. Roberts (1992), Economics, Organization & Management, Upper Saddle River, N.J.: Prentice Hall.

Podolny, J.M. (1994), *Market Uncertainty and the Social Character of Economic Exchange*, Administrative Science Quarterly, 39:3, 458-483.

Popielarz, P., & J. M. McPherson (1995). *On the edge or in between: Niche position, niche overlap, and the duration of voluntary memberships*. American Journal of Sociology 101:698-720.

Schneider M, Teske P, Roch C, Marschall C. (1997), *Networks to nowhere: segregation and stratification in networks of information about schools*. Am. Polit. Sci. Rev. 41:1201–23

Shrum W., N. H. Cheek, Jr., S. M. Hunter (1988). *Friendship in school: Gender and racial homophily*. Sociology of Education. 61:227-39.

Spence, A. M. (1973), *Job Market Signaling*. Quarterly Journal of Economics. 87 (3): 355–374.

Stiglitz, J.E. (2000), *The Contributions of the Economics of Information to Twentieth Century Economics*. The Quarterly Journal of Economics, 2000, vol. 115, issue 4, pages 1441-1478.

Stiglitz, J.E. – Weiss, A.M. (1981), *Credit Rationing in Markets with Imperfect Information*. American Economic Review, 1981, vol. 71, issue 3, pages 393-410.

Tirole, J. (1988), *The Theory of Industrial Organization*. Cambridge: MIT Press.

Uzzi, B. (1996), *The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect*, American Sociological Review, 61.

Varian, H. (1988). "Price Discrimination." In *Handbook of Industrial Organization*, eds. R. Schmalensee and R. Willig. Amsterdam: North Holland.

Verbrugge, Lois M. (1977). "The Structure of Adult Friendship Choices." *Social Forces* 56:576–97.

Weisbuch, G., Kirman, A. and Herreiner, D. (2000), *Market Organization*, Economica, 110, pp 411-436.

Wilson, R. (1993). *Nonlinear Pricing*. Oxford: Oxford University Press.

Wright EO. (1997), Class counts: Comparative studies in class analysis. New York: Cambridge University Press