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## Competition Between Networks

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### Abstract

*The main subject of this paper is to explain and investigate the results and structure of the competition between two networks. The article proceeds in the following manner. First, it briefly reviews the literature regarding alignment, new economy, network externality and networks. Second we set up a simple model to explain competition between two networks. As a result of this competition one of the networks can be winner. But in new economy “winner takes all” rule works. If the winner network reaches to critical mass, the value of his/her good increases for customers. Because of lock-in effects, network competition can be finished by monopoly or dominant network. In other words network competition promotes monopoly. This result is convenient with previous academic studies.*

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### 1. Introduction

After the invention and diffusion of internet, we are witnessing great transformations in economic and business structures. One of these great revolutions is realized in markets. Today classical Micro economic theory is insufficient to explain the dynamics of markets. One of the important differences between classical theory and today’s reality is networks. Some markets consist of at least one network in modern economies. These networks are competing to be a standard in markets. The aim of this study is to investigate the competition between networks. To this end, we followed this way. First, we briefly review

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the literature regarding networks, network competitions and network externalities. Second we build a model that explains the market consist of at least two networks, we mean oligopoly market. Third we explained how firms compete with each other by looking through near historical competitions. Classical wisdom states that network competition can be resulted by a monopoly market. Finally, we provide findings of our model and discuss in what conditions the network competition can be ended through monopoly market.

## **2.Literature Review**

Internet and information technology has changed many things including markets and economy dynamics, in our daily life. Cass called the period after the diffusion of Internet as a fifth fluctuation that changes all of the economic life and the nature of business (Rubin,2001,p.1; Çinko,2003,p.158). Improvements in Information and Communication Technology (ICT) are thought to be the reason of the new economic situation. Today economics, markets, competition can not be explained by classical micro economic theory that is built by Adam Smith, David Ricardo, Jean Babtiste Say etc in the late 1700's and 1800's. Probably one of the most important differences between today's economy and classical theory is the presence of networks (Söylemez,2001,p.27).s Therefore Castells (2006,p.6) used "Network society" to determine new social environment. Also one of the terms that are used to determine today's economy is network economy (Özgüler,2003,p.2). Networks are not entirely new term, but there has been a rapid increase in their number, transformation in their complexity. Economic studies about networks were started after 1980's (Katz and Shapiro,1985; Farrell and Saloner,1986). Kelly (1998,p.26) told that in a new economy, value is created and shared by all members of a network rather than by individual companies or customers.

Nowadays not only most of the firms are competing with cooperation each other, but also networks are competing too. The companies such as Wal-Mart, Dell etc. are defined as a part of network (İşler,2008,p.288). Also we are witnessing that some companies are producing or launching network components that are compatible to products that are produced by other firms. In other words these companies are cooperatively moving and forming networks. The academic searches about networks were largely based on externalities. The main studies about network externalities were published in 1980's (Katz and Shapiro,1985; Farrell and Saloner,1986). Networks exposed externalities to consumers and we call these externalities as consumption network externalities. In today's economy, there are many products for which the utility that a user derives from consumption of the good increases with the number of other agents consuming the good. These are called as Positive Network Effects in economy. Katz and Shapiro (1985) studied network externalities, classified the reasons of these positive externalities, draw distinction between direct and indirect externalities. According to Liebowitz and Margolis (1994,p.134)

“Goods exhibit a network externality wherever the consumer enjoys benefits or suffers costs from changes in the size of an associated network, that is, changes in quantities demanded”

Network externalities can provide direct or indirect sources (Katz and Shapiro, 1985,p.424). Some communication technologies such as Telephone, fax machines, the utility of consumers directly depend on the size of a network. For example if only one customer has telephone, then the value of telephone is nothing. As using the number of telephone increases among the customers the value of it starts to increase. This is direct source of network externalities, but also there is indirect source of externalities. Consumers know that if the usage of product increases, then it will be easy to find spare parts and equipments that are adaptable to this product.

There are many studies that searches about networks and it's externalities on economic literature (Katz and Shapiro,1985; Farrell and Saloner, 1986; Shapiro and Varian, 1999; Liebowitz and Margolis, 1994; Kelly, 1998; Matutes and Regibeau, 1988; Economides, 1989; Economides,1996; Farrell and Klemperer, 2006, Brynjolfsson and Kemerer, 1996; Stoneman, 1987). Kraus (2008) concerned with making adjustments to capacity of a network. Polanski (2007) set up a model that searches the impact of an exogenous connection structure of the network on the prices of information good.

### **3.Assumptions And Model**

We can construct a model that provides us to explain the dynamics of network and market structure. We start to our model with consumers and finish with firms. Today, the structures about the markets are more complex than before. Our models have two networks which are competing with each other. By supposing two networks, we simplified all of the market structure and with the help of this model, we can easily determine the relationship between networks and markets. By constructing our model, we considered the network models, that was constructed before (Katz and Shapiro,1985; Economides,1989; Economides,1996; Bental and Spiegel,1995) and we benefit from histories lived in markets (Masanel and Yoffie,2007; Spinello, 2005; Brynjolfsson and Kemerer, 1996; David,1985). These stories are about QWERTY keyboard, IBM PC standards, software market etc (Gallaughar and Wang, 2002). Also we discussed if network competition supports the formation of monopoly market. We will test in what conditions monopoly market forms.

The assumptions of our model are below.

- 1-) All of the consumers and agents are rational. They want to maximize their utility without spending too much. All consumers have identical tastes. Also they can change their network without any transaction cost.
- 2-) There are two networks which we will call Network X and Network Y. Each network is commanded by a centre firm. But there are complementary firms, too. Choosing a network means choosing both main and complementary goods. For example; if consumer chose PC standard instead of Mac standard then

consumer would use PC compatible hardware and software. Both networks produce the goods with same characteristics. The quality of goods only depends on both the decisions of firms and the number of customers. Networks are not compatible with each other.

3-) There are  $M$  consumers in the market.  $M$  is a positive integer. We suppose that  $M$  is big enough to create effective network. If one of the networks reach big enough market share, the network will be attractive to participate for consumers. Therefore, the network size and market share are not used in different manner. The participants of the Network  $X$  is  $M_x$  and the participants of Network  $Y$  is  $M_y$ . Of course each consumer has different tastes, but to facilitate our computations we assumed that each consumer has same tastes and every consumer is identical.

$$M_x + M_y = M \quad (1)$$

We concentrated on the competition between two centre firms and ignore the actions of complementary firms. Both of two centre firms want to get large share of market and get maximum income because they are rational agents. We can summarize the structure of our model by figure 1.

4-) We ignore the negative consumption network effects. Liebowitz and Margolis (1994,p.134) mentioned about the negative network effects. For example; telephone or computer network can be overloaded, so the effect will be negative on individual consumer. We mean that consumers can suffer from the last participant of network. Economic literature generally mentions about three sources of network externalities. First source is directly related by the connection number. If a new customer participates to a network, the other participants in network can make more connection than before. Secondly consumers, who prefer the network with largest installed base, can find complementary goods easily. For example; if customer purchases IBM PC type instead of MAC, he can find compatible software easily. Third consumers can reach post purchase services easily if they chose the network with largest installed base (Katz and Shapiro,1985,p.424-425)

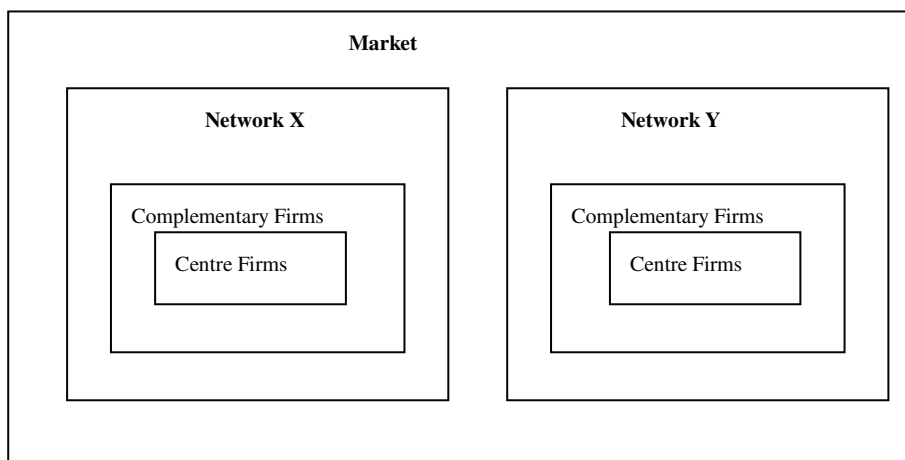


Figure 1. The Structure of the Market

As it is seen in the Figure 1, Network X and Network Y are competing in a market. Both Networks have centre firms and complementary firms. Centre firms are institutions which set up the rules and standards of networks. Complementary firms are producing goods that can be used by the goods which are produced by centre firms. For example; Microsoft and İNTEL are setting up the rules of IBM PC type computers and other software and hardware firms are producing goods compatible to the products of İNTEL and Microsoft (Windows operating system). Therefore Microsoft and İNTEL are Centre firms of networks, also other hardware and software firms are complementary firms. Today WINTEL is one of the classical network examples.

#### 4.Competition Between Network X And Network Y

Consumption network externalities are valid when the number of consumers, who purchase this good, is an important quality characteristic of that good, which affects the utility of consumers either directly or indirectly. According to previous academic studies quality is a variable that is under the full control of the producer. If the firm wants to increase the quality of a good, he will use high quality raw materials, qualified employees. So it can be set independently of consumers' behavior (Bental and Spiegel,1995;197). Because of the network externalities, a producer can not fully control important quality characteristics of the product. He has to consider about the number of consumers. In network markets one of the variable, that affects quality of a good, is the installed base of network. The value of a network good is shown by Gallaugher and Wang (2002,p.305) (Figure 2).

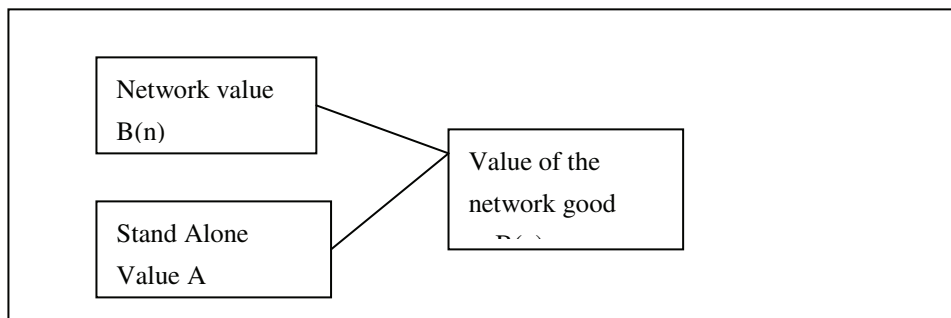


Figure 2. Typical Theoretical Model For Network Goods

By using Gallaugher and Wang (2002), we can define quality function of a consumer mathematically by (2). The utility function of consumer consists of two parts. First part is own utility of a good and second part is the utility that is the result of the number of consumers. In this definition  $q$  denotes the quality of the good which is under the control of producers. As the market share increases, the quality of the good increases, too.

$$Q_{ux} = f(q, M_x)$$

$$Q_{uy} = f(q, M_y) \quad (2)$$

Producer can choose to produce a good with high quality and to realize this, it can use high quality raw materials and high qualified employees in production. But also the firm must encourage consumers to join a network in order to make the network more attractive. However, consumers have different incomes, and this is the starting point of the firm. The firm has two different choices now. First, the firm can only charge the price that the poorest consumer who joins a network is willing to pay. But if the production costs are high, it will not be possible to charge such a low price. Also richer consumers can think that the quality of a product is low. Second, the firm can exclude the poorest consumers from the network by charging high prices, but this time the willingness of the richer participants to pay is reduced on this account. Shortly, the firm has to find a way to lump rich and poor consumers together, because richer consumers are willing to pay more for a larger network (Bental and Spiegel, 1995, p.198-199). We will show the effects of firms' strategies later.

The utility of a consumer depends on the quality and quantity of a good bundle. We don't ignore the quality of a good (or good bundle as we used in our model) like classical microeconomics. We can show the utility function of consumer. The consumption quantity is shown with  $Q$ . Decreasing marginal utility is valid, but we will not consider about it anymore. The utility function of a consumer by participating Network X is shown in (3) and Network Y is shown in (4). These functions are simple forms of utility function in Lambertini and Orsini's study (2001, p.971). Their function is shown with  $U = \max\{0q + ax - p, 0\}$ . As it is seen they used prices ( $p$ ) in utility function.

$$U_x = f(Q_{ux}(q, M_x), Q) = f(q, M_x, Q) \quad (3)$$

$$U_y = f(Q_{uy}(q, M_y), Q) = f(q, M_y, Q) \quad (4)$$

Rational consumer, who wants to maximize his/her utility, will benchmark utility functions and make decisions about consumption. If

$$U_x \geq U_y \quad (5)$$

Then consumer will decide to participate Network X. Else or in other words

$$U_y \geq U_x \quad (6)$$

Then consumer will decide to participate Network Y. The decision problem of consumer is given in (8). Income of a consumer is stable and we show it with  $Y_c$ .

$$\max\{U_x, U_y\} \quad (7)$$

$$Y = Y_c$$

So how does the centre firm act to affect the decision of a consumer? Of course also the reactions of complementary firms affect consumers' decisions, too. But their affection power is too low according to centre firms. As we mentioned before, we ignore the competitive actions of complementary firms. Economides (1989,p.1166) showed that equilibrium prices and profits are higher under compatibility. So, participating a network relates to desirable solutions for firms.

The utility of some products for consumers increases with the number of other agents consuming the good. This term is called positive consumption externalities and there are several possible sources. First positive consumption externalities can be generated through a direct physical effect of buyers. Generally in communication technologies, the last consumer, who participate network, will increase possible connections of all other users. For example if one consumer is added to telephone network, all others can connect with him by using telephone. So the increase in the number of consumers, affect the utility of others. Second consumer can reach complementary goods easily if the good is used widely in a market. For instance, consumer knows that if he/she chooses VHS type video player, he/she can easily video cassettes easier than Beta type video player. Third the quality and availability of post purchase services for a good depend on experience and size of the service network. It is clear that the experience and size of the service network vary with the number of goods that have been sold (Katz and Shapiro,1985p.425).

Generally, the decisions of two players, who evaluate the strategies of their rival by using probability calculations, are used as a strategy in micro economic theory (Eren,2002,p.4). What can centre firms do to compete with each other? How do they convince consumers? If they want to affect consumers, they should consider about the utility function of rational consumers. We recall (3) and (4). The utility function of consumers depends on production costs, market share and consumption quantity. If centre firms want to increase the size of network, they should adjust these variables. We concentrated on some strategies of centre firms.

*Raising quality of a good.*: First centre firms can increase the quality of a good by using high quantity raw materials and qualified employees. Rational consumers are sensitive to quality of a good. They want to maximize their utility and they can do this by selecting network with high quality good. Nowadays Research and Development activities provide production of higher quality goods. However, if costs increase, firms must increase the prices, too. In Demand theory we know that if prices increase, demand quantity will decrease. Small installed base that can be produced from high prices, has negative effect on consumer utility function. In addition, quality of a good does not only depends on costs but also on the size of network. For example; many authors decided that Beta type video players are more useful and have higher quality than the VHS type video players. But VHS type video players become standard in market and win the competition against Beta type video players.

*Pricing*: Lower pricing is colliding with the first one. Rational consumers are also sensitive to price of a good. They want to maximize their utility with lower costs. To reach more demand, centre firms can charge lower price to enlarge the size of network. But firms, who want to increase quality of a good, have to charge high prices. So these strategies are colliding with each other. Larger size networks remind the term "critical mass". Network effects become significant after a certain subscription percentage has been

achieved, called critical mass. Economides and Himmelberg (1995,p.5) defined critical mass as the smallest network size which can be sustained in equilibrium. At the critical mass point, the value obtained from the good or service is greater than or equal to the price paid for the good or service. So if centre firms become successful to reach critical mass, they can benefit from positive network externalities. Potential customers will prefer the larger size network and in a short time market can become monopoly. Software products can be classified as digital or information goods with a corresponding theoretical marginal cost of zero. Because of this character software markets witnessed different stories in the world. For example; summary of browser competition is given in Chiaravutthi (2006) and CD industry competition is given in Basu and others (2003,p.212). As a result the concept of critical mass formalizes the "chicken and the egg" paradox: generally rational consumers are not interested in buying the good because the installed base is too small and the installed base is too small because an insufficiently small number of consumers have bought the good.

Lower pricing can encourage consumers to purchase more good. Rational consumers will decide on consumption quantity by considering decreasing marginal utility, their income and prices. Until their marginal utility-price ratio becomes equal to other good's ratio, consumer will go on purchasing this good. But in network economies, something is different. The willingness to pay for the last unit may increase with the number of units sold (Economides and Himmelber;1995,p.4). In other words, customers in a network decide to buy more good. Therefore centre firms can reach critical mass quickly and the same result can be reached by second one.

*Raising Both Quality and Pricing:* The most desirable act for firm is to apply both raising quality and lower pricing. It is not easy for firms, but they pay too much for Research and Development (R&D) activities to realize this. As a result of R&D activities, firms can improve their good and raise the quality of their good without any cost. In new economy generally the cost of first product is higher, but after first production, marginal costs are lower (Söylemez;2001,p.24). For example; a software firm can improve his/her good by paying much for R&D activities. But after this high cost, the firm will pay only for CD to increase production. If firm become successful to raise quality of a good with lower costs, He/she can charge lower prices.

### **5.Promoting Monopoly**

Lower prices and high quality will encourage consumers to buy the good of centre firm. Economic literature concerned about the importance of R&D activities for firms. Lim and others (2004) studied about technological competition in network economies and they argued that network features will increase R&D investments. Assume that centre firm of network X become successful to improve his/her product with lower costs, while centre firm of network y was not successful. So, the utility function of a consumer by participating Network X will change. (3) Equation will become like (8). Now new utility function ( $U_{x1}$ ) is bigger than the old utility function ( $U_x$ ).

$$U_{x1} = f(Q_{ux}(q + \Delta q, M_x), Q) = f(q + \Delta q, M_x, Q) \quad (8)$$

$$U_x = f(Q_{ux}(q, M_x), Q) = f(q, M_x, Q)$$

Utility of network X increases while utility of network Y decreases. The utility function of a consumer by participating Network X is bigger than Network Y.

$$U_{x1} \geq U_y \quad (9)$$

So we will see two effects. First new participants, who are outside of the market, will come to Network X. Second, participants of Network Y will change their network and participate to Network X. Because of these movements, Network X can reach to critical mass. Therefore the utility function of a consumer by participating network X will increase by the help of network externalities. It will be more difficult to deny Network X. Metcalfe, inventor of the ETHERNET Computer-Networking Technology, says that the value of a network is proportional to the square of the number of connected users of the system (Villasis,2008;2). For example; two telephones can only make one connection, five telephones can make ten connections and twelve telephones can make 66 connections. If the number of connection is important part of good quality, quality will increase proportionally to the square of the number of users. The competition started to be against network Y and in favor of network X.

Lock-in is an important result of critical mass. If one of the networks become dominant in a market and reach critical mass, his/her good can make lock-in effect in a market. Consumers can prefer the good, which is locked in, although rival good is cheaper and have higher quality. Classical Lock-in effect is realized in keyboard competition (David, 1985). Although F type keyboard is more useful and faster, because of lock-in effect most of the consumers can prefer to purchase QWERTY keyboard.

Kim (2002,p.398) thought that incumbent monopolists never has an incentive to invite entry if the goods are homogeneous. In other words for homogeneous goods firms wish to become monopoly. Albeit the centre firms will not have monopoly power, they can be a part of dominant network in this model. Shortly, positive network externalities promote monopolies. There are many examples of dominant networks that become after competition between networks (Spinello,2005; Economides and Himmelberg, 1995; David,1985).

## 6.Findings and Conclusions

Networks have been in the centre of economic literature since 1980's. Also economic history witnessed interesting network competitions (Karnik,2000; David,1985). We explained the competition of two networks by using simple algebra. Conventional economic wisdom claimed that network externalities promote the formation of monopoly markets in short run. Of course, in the long run new firms can launch new products that can create new platforms, in other word new entries threaten monopolies (Tirole,1992,p.392). In the competition of two networks, if centre firm of one network become successful

to convince most of the customers, incumbent network can win this competition. As number of the customer of the firm in the market increases, the value of the product for consumer increases. This is just the solution of positive network externality. If there is not capacity problem, network externality will promote the formation of monopolies. Critical mass is important term that supports incumbent network. If installed base of a network reaches critical mass, customers can be attracted from this base and decide to purchase goods of incumbent network. These network goods create lock-in effect in a market. Customers can not easily return to other network's good. Shortly network externalities, lock-in effect, critical mass promote the monopolies. Further studies should be done to illuminate the background and results of network competition in Turkey.

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