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# The Nature and the Significance of Network Industries

*"Telecommunications as an Example"*

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# The Nature and the Significance of Network Industries

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## ABSTRACT

*The main purpose of this paper is to put how network industries differ from other industries and to analyze how these industries work. Beside this main purpose, the paper also aims to examine evolvement of those industries throughout recent technological changes. In doing so, telecommunications industry is studied as an example. The composed information cited in this paper suggest that main network specific features -network externalities, demand-side economies of scale and role of compatibility- have differed network industries from non-networks. In addition, technological progresses have played a major role for the evolvement and the restructuring of network industries.*

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## 1. Introduction

Network industries, such as telecommunications, electricity, airline and railway transportation, computer hardware and software markets, banking services, etc., are the crucial and indispensable elements of modern economies. Recent technological changes have expanded the importance of those industries in terms of their effects on countries' growth performance and competitiveness of countries. Many researches in economics, law, business and engineering areas have begun for well operating networks.

The main purpose of this paper is to put how network industries differ from other industries and to analyze how these industries work. Beside this main purpose, the paper also aims to examine evolvement of those industries throughout recent technological changes. In doing so, telecommunications industry is studied as an example. Telecommunications has been chosen because of two main reasons: first, it includes most of the network specific characteristics; second, latest technological progresses have forced to restructure the industry more than other network industries. The composed information cited in this paper suggest that main network specific features -network externalities, demand-side economies of scale and role of compatibility- have differed network industries from non-networks. In addition, technological progresses have played a major for the evolvement and the restructuring of network industries.

The organization of the paper as follows: The second section indicates the nature of network industries. While the third section elaborates some important network specific features, the fourth and the fifth sections employ competition and welfare aspects. The sixth and seventh sections are fully devoted for telecommunications. And, final section includes concluding remarks.

## 2. The Nature of Network Industries

As a simple definition, a network is a system that consists of points and interconnecting lines to transmit or transfer flow of information, energy, or any appropriate material for the system. However, the system has not to be consisted with an integrated firm or a single supplier; there may be non-integrated individual firms. For instance, in many network industries; such as energy, electricity and telecommunications; collection or generation (upstream) and supply or distribution (downstream) stages are exploited by different non- integrated firms.

Network industries play a crucial role in our daily life. Electricity, water supply, gas, telecommunications, transportations and information networks are the indispensable elements of the modern life. Those industries deliver services and products for general public or for business sector. It has to be taken into account that the quality, the quantity and the price level of those products and services are the crucial determinants of the competitiveness and the development level of the countries. Thus, the importance and the significance of network industries should be considered beyond their share in countries' GDPs.

Comparison of network industries with other industries gives us a fundamental difference: existence of natural monopolies. A natural monopoly arises because a single firm rather than more firms can supply a good or a service for the entire market with a possible lower cost. Existence of a natural monopoly indicates significant economies of scale. Thus, it can be argued that establishing a network structure indicates a costly process because of high fixed costs. Then, when a firm is a natural monopoly, it is less concerned about new firms for a threat of its monopoly power. This indicates the dominance of incumbent firm. More specifically, the existence of economies of scale creates technologically natural monopolies. Since, the unit cost of product decrease sharply in economies of scale, this technological consideration prevents the duplication of the infrastructure of the network.

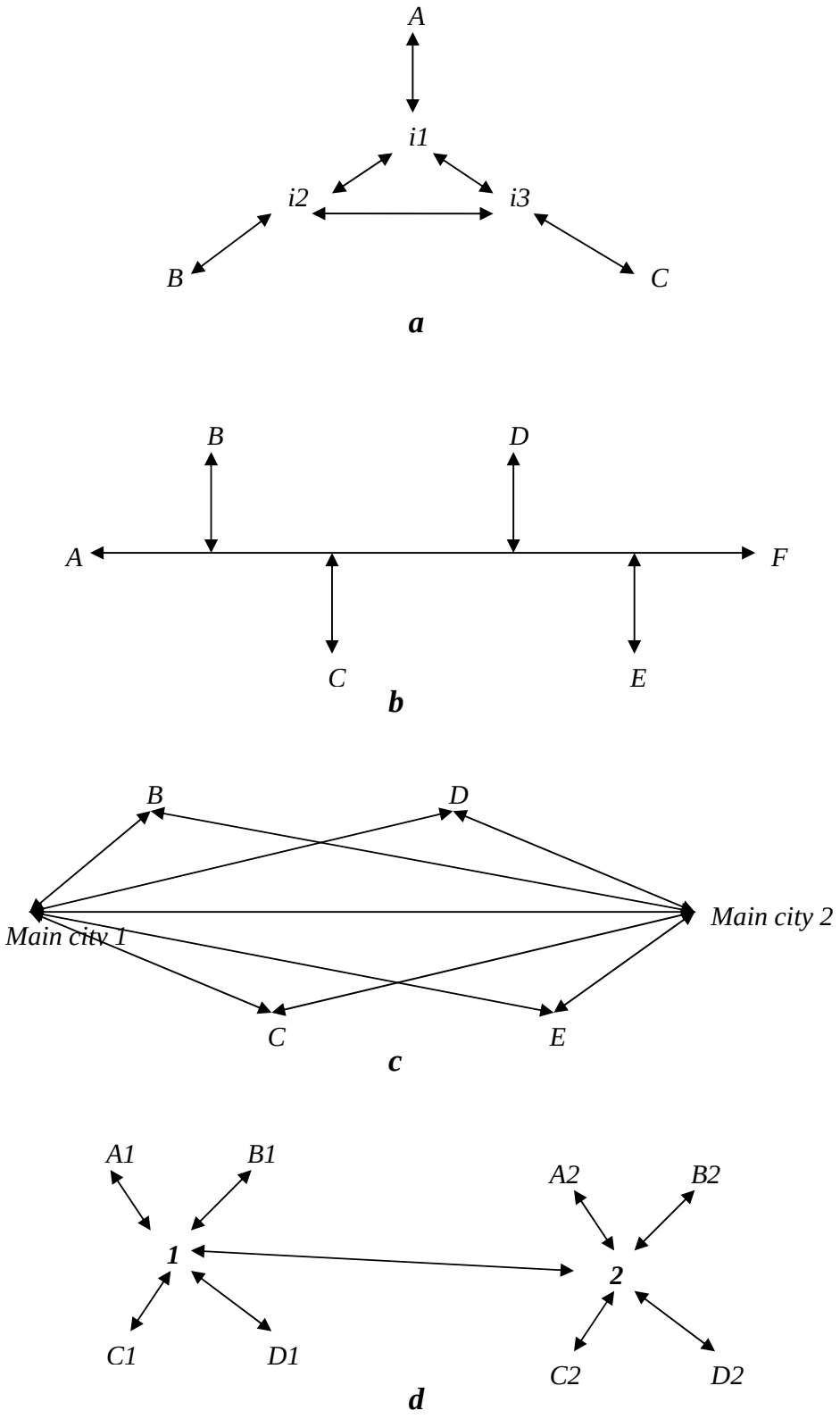


**Figure 1:** Different configurations of networks

Although in the first look it appears that natural monopoly is a common characteristic of all network industries, in fact the extent of natural monopoly is not the same in all industries. "*As technology changes, the natural monopoly changes*" (European Commission 1999, p.87). This change either arises from a technological improvement in the specific sector or technological developments in other areas.

For instance, in telecommunications, rapid technological progress has increased the productivity and led to decrease the costs of connecting calls dramatically. Thus, natural monopoly element is shrinking throughout technological developments in telecommunications sector. More specifically, "*the cost reductions have transformed the telecommunications industry from a natural monopoly to an oligopoly*" (Economides 1996, p. 678). On the other hand, in water sector there is no alternative for the existing network, then the natural monopoly has a great extent.

As mentioned at the beginning of this section, the network usually consists of points and interconnection lines for those points. The structure of the interconnection exhibits a significance importance for the configuration of the network. More specifically, building and operating costs, storability of the product, and homogeneity of the product play crucial roles for the design of network configuration. In other words, all networks require their appropriate configurations.

For instance, the railway transportation exhibits high operation and building costs. In fact, one can mention a trade off between operating and building costs. Because, shorter lines reduce the building costs, on the other hand it increases the operations costs throughout increasing average duration of travel (European Commission 1999). Thus, it requires interconnected sub networks as shown in figure 1a.

The motorway transportation requires a similar but different configuration because of high building and maintenance costs, but relatively low operating costs. Thus, along a main road, there can be constructed some secondary roads for

interconnection (See figure 1b). In opposition to the railway or motorway transportation, airway transportation exhibits mostly operating costs. Since the airlines are free, the interconnection materializes from point to point as shown in figure 1c.

However, the telecommunications exhibits a different structure. In the most basic case, it can be considered the interconnection of two local networks. As exhibited in figure 1d, a local call can be realized within the local network. But a long distance call can be realized throughout two local networks by an interconnection of two local centers (1 and 2).

In addition, the storability characteristic of the product subjected to the network also affects the configuration of the network. For example, while electricity is considered as non-storable, water and gas are storable goods. Thus, their network configuration may exhibits differences. While electricity requires direct connection to the final consumer, gas and water may be obtained from local stations by the final consumers.

On the other hand, the homogeneity of the product may also affect the structure of the network. Since the gas, electricity and water are homogenous and not to need special addresses. On the contrary, telecommunications services subject to special addresses. Thus, the homogeneity of the product requires different network structure according to the product's homogeneity level.

The last issue before starting the network special aspects may be the key determinants of the organization of networks. In fact, in different countries, the same network industries exhibit different organization structures. More clearly, those industries' organization depends on the tradition, culture and the specific condition of the sector. Basically, the key dimensions in the organization of network industries can be expressed around three issues: decentralization or centralization, vertical integration or separation and private or public ownership (Schmidt *et al*. 1999, p.24).

For instance, in most of the European countries there exists a public ownership in railway transportation except in United Kingdom. Moreover, in electricity industry, while vertically integrated firms exist in France, Italy and in Greece; vertically separated firms operate in Portugal, Spain and in United Kingdom.

## 3. Fundamental features of network industries

In this section, I will present two fundamental features that are more specific to network industries rather than non-networks. Those are the role of *technical compatibility* and the existence of *network externalities*. Those special features create a network specific market structure that I will present in the following paragraphs.

As mentioned in the definition, a network consists of points and interconnecting lines. The technical compatibility plays a crucial role in order to connect those points throughout lines. More clearly, if compatibility exists, then the lines and the points are costlessly combinable to transmit or transfer the flow information, energy, etc. In fact, this signifies an important issue of network industries, complementarity. In other words, in case of compatibility the goods produced or consumed in a network become complementary for each other.

For instance, most of the national and international networks, such as telecommunications or railways, have been developed by progressive interconnection of appropriate local networks. This raises the importance of technical compatibility as an important issue for both national and international levels. Thus, standardization appears as a fundamental issue for the structure of the entire networks, which will be interconnected.

According to Shapiro and Varian (1999), the technical compatibility feature of network industries, has changed a paradigm for the competition strategy. As they

mentioned, traditional rules of competitive strategy focus on the competitors, suppliers and the customers. But a representative firm in a network industry, especially in information industry, focuses not just on its competitors but also on collaborators and complementors (p.10). Because, the good produced by the firm is a component of the system and the firm cannot compete if it is not compatible with the rest of the system.

For instance, the history of Microsoft – Intel partnership is a classic example for the technical compatibility issue. For the production of personal computers, while Microsoft focused on software, Intel focused on hardware. Throughout some strategies[1], Intel and Microsoft have created a competitive industry for the personal computer production. On the other hand the other main competitor, Apple Computer, followed a different strategy by focusing on both hardware and software. Although the software hardware combination of Apple exhibited a better performance, the relative lack of competition made Apple products more expensive (Shapiro and Varian 1999).

The compatibility issue has arisen some other network specific concepts which are called *lock-in* and *switching costs*. Considering the above example, assume that a firm has produce goods or services by using an infrastructure operate on Apple (Macintosh) system. In case of discovery of a more productive PC based production system, the firm faces a significant cost to switch (switching cost) from Macintosh to PC. In fact, the switching cost does not consist of only purchasing of a new system; it also covers the switching cost of personal training for the adaptation of new system, etc. If the switching costs are significant for the firm, it is said that the firm is *locked-in*. Since degree of lock-in is determined by the cost of switching to a different system or adopting new technology, the lock-in is not an absolute term (Shy 2001). This problematic issue does not occur only in information economy; those can be

[1] Intel has helped to create highly competitive industry in component parts throughout entering new product spaces such as chipsets and motherboards to improve the performance of these components. And, Microsoft has pursued a strategy to create multiple sources for its partners' piece of the system (Shapiro and Varian 1999).

observed in telecommunications, airline transportation, banking sector, etc. In addition, those can occur in individual level as well as company level.

On the other hand, existences of different systems or technologies allow some special effects, called *network effects* or *network externalities*. In conventional terms, an externality is defined as the uncompensated impacts of one agent's action on the well-being of other agent(s). Just like in the conventional definition, when the value of a product or a service depends on the number of other users of the same service or product, network externality arises.

The network externality can be direct or indirect. The direct externality exists if the customers identified with components. For instance, most of the telecommunication technologies exhibits direct network externalities: telephone users benefit from the others from being a member of the same network; likewise, computer users of compatible versions benefit from the large number of users.

Those direct effects or externalities sometimes considered as positive or negative feedbacks. When two or more firms compete for a market where there exist strong positive feedbacks in terms of direct externalities, only one firm may emerge as the winner (Shapiro and Varian 1999). The key reason is the positive feedbacks which makes the strong get stronger and the weak get weaker.

The indirect network externalities usually concern with one-way networks. Because of the presence of the economies of scale in production, higher number of complementary products can be supplied with lower price. More specifically, an extra consumer yields indirect externalities to the other consumers, by increasing the demand for the components of the network (Economides 1996).

There are two important issues related with the network externalities. The first issue lies on the demand side, Because of interdependent utility functions, users anticipate which technology will be widely used with the others. That issue

introduces coordination problems (Tirole 1994). For instance, when such network externalities are strong, product announcements exhibits a special importance. As Shapiro and Varian (1999, p. 15) emphasizes, product pre-announcement can be a two edged sword: the announcement of a new, improved version may cut into competitors' sales, but it can also cut into the firm's own sales.

The second issue related with the network externalities lies on the supply side. In other words, the issue is related with the way of technologies are chosen and promoted. In the presence of network externalities, the standards are generally mandated by government or some special bodies, such as industry comities (Tirole 1994). From railroad tracks to the internet mail services, various examples in national and international level can be cited for that issue.

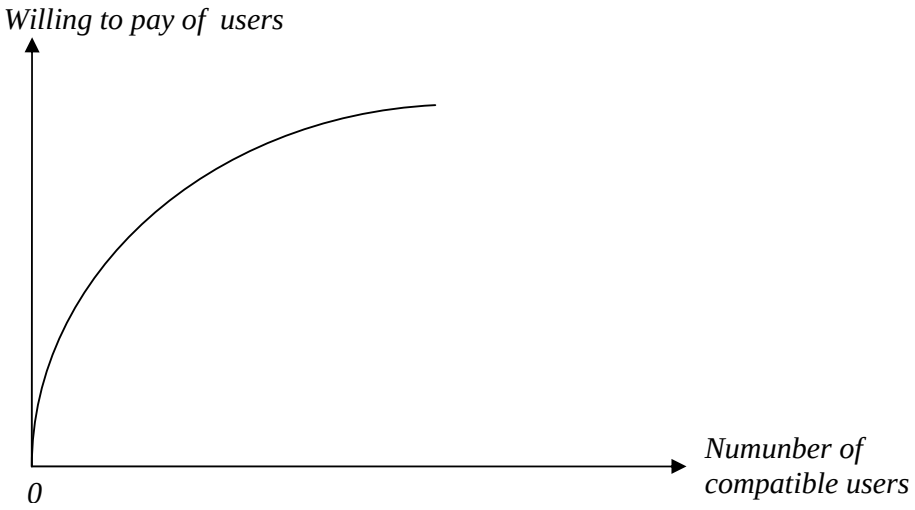


**Figure 2:** Willing to pay of users for a network good

As a final network specific issue, I would like to emphasize on the demand for network goods. As a well known assumption for all normal goods in economics, the demand curve has a downward slope. However, for the network goods, in the presence of network externalities, the fundamental law of demand has been violated. More clearly, as the quantity demanded increases the agents' willingness to pay also increases. This issue can be seen in figure 2.

## 4. Competition in networks

Existence of network externalities, role of compatibility, divergence of competitive equilibrium, existence of natural monopoly because of significance economies of scale are the major determinants of competition and welfare aspects in a network industry.

For the network competition, network externalities and the compatibility decision are the major features. The existence of the network externalities ensures a large number of potential equilibrium set, for the competing networks. In fact, because of the network externalities, the potential level of a network depends on the consumer choices, which are related with total number of customers in each competing networks. In figure 3, the existence of multiple equilibrium case can be seen with a hypothetical function of potential customers (*n(p,N)*), who would like to be a member of given network.

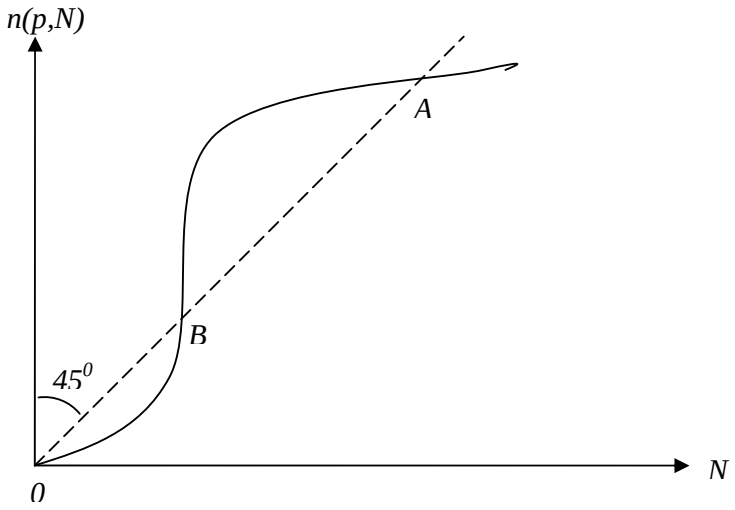


**Figure 3:** Multiple equilibrium in network competition (adapted from European Commission 1999, p.92)

In the figure, *N* represents number of actual customers of the given network and, *n* is a decreasing function of *p* (price) and increasing function of *N*. Two

hypothetical equilibrium exhibits an unstable and a stable equilibrium, *A* and *B*, respectively. Accordingly, for the stable equilibrium *A*, if an exogenous shock has occurred a new equilibrium emerges. However, the unstable equilibrium, *B*, indicates a critical solution: if one member of the network leaves, several other follow him; if one additional member has been included, it creates a positive network effect. In technical term, the unstable equilibrium *B* called a *critical mass*.

According to Katz and Shapiro (1985), in the presence of network externalities, consumers make expectations according to the size of competing networks. They use a notion of rational or fulfilled expectations equilibrium, for those I have already presented in the previous paragraph. And, their basic findings suggest that network externalities give rise to demand-side economies of scale, which depends on consumer expectations. "*As a result multiple fulfilled expectations equilibriums may exist for a given set of cost and utility functions. For some sets of expectations only one firm will produce output, while for other sets of expectations there will be several firms in the market* "(p.425). In sum, consumers' expectations are the important determinants of the equilibrium and the existence of the dominant network in the market.

The second key feature of the network competition is the compatibility. Since the utility of network goods depends on the number of their users, a decision of compatibility between several products or services dramatically changes the size of the customer-networks (European Commission 1999). Thus, any network firm faces a dilemma whether to produce compatible product or not. Through a model, Katz and Shapiro (1985) compare the private and social incentives to produce compatible products. Their findings indicate that network firms with good reputation or large networks will tend to against compatibility. Conversely, firms with small networks and weak reputation will tend to produce compatible products. Moreover, in the presence of multiple equilibrium, when products are incompatible firms' reputation plays a major role for the determination of the equilibrium.

On the other hand, to reach the critical mass, in order to survive in the industry, each competitor tries to persuade the potential customers that his network will be the best one. In fact, those kind of competition strategies need to be elaborated in a dynamic comprehension (European Commission 1999). For instance, in the early stage of competition, huge advertising campaigns and public relations activities take place to gain the credibility of the potential customers. Also, low introductory prices and promotional activities are set in motion in order to offset the probable switching costs.

## 5. Welfare aspects

In the presence of network externalities it is evident that competitive equilibrium does not exist in any network industry. In other words, because of the violation of the First Welfare Theorem, the competitive solution does not exhibit a Pareto efficient characteristic. In the first look, this situation suggests a market failure.

Although the divergence from Pareto optimal arises from several reasons, Katz and Shapiro (1994) suggest three network specific reasons. First, and of course, the network externalities which are not internalized by any market transaction play the major role. Second, existence of economies of scale and product differentiation arises often in oligopoly or monopolistic competition not in competitive equilibrium. Third, due to the importance of R&D and innovation, together with the chance of tipping these markets are often characterized by (temporary) monopolies.

More words for the perfect competition yield that the marginal social benefit of network expansion is much larger than the captured by any firm in perfect competition. This issue suggests that perfect competition will provide a smaller network than is socially optimal. The problem arises here as, how a welfare maximizing solution can be achieved in the presence of network externalities.

Although the solution is suggested as perfect price discrimination, this solution seems unfeasible (Economides 1996).

Since the perfect competition cannot suggest a feasible welfare maximizing solution, can a monopolist suggest a Pareto improvement solution then the perfect competition? As suggested by Economides and Himmelberg (1995), influence over expectations forces a monopolist in a network industry to produce in higher level, but the profit maximization objective of the monopolist drive the production level in lower level. Thus, consumers and the total surplus yield lower than the perfect competition case. On the other hand, the authors' findings suggest that oligopolistic market structure support network smaller size than perfect competition and larger than monopoly.

The above discussion, which indicates misallocation of resources and Pareto inferior situation, signifies a typical market failure. The probable causes of this distortion arise from non competitive behavior of firms or by the network externalities. In industries other than network industries, the existence of market failure needs to be government intervention. However, in network industries "*the existence of market failures does not imply that government intervention is needed. In fact …* (some) *examples illustrate that government intervention may make things even worse*" (Shy 2001, p.6). In other words, there is no guarantee that government intervention would ensure a Pareto improving situation.

According to Katz and Shapiro (1994), there are some important issues that must be addressed before concluding that government intervention gives a desirable solution. First, the range of the market efficiency is unclear. Once it is recognized, there would be some self responses of the private institutions to achieve coordination and internalizing externalities, without government intervention.

Second, it has to be taken into account the future effects of the government intervention. More clearly, government intervention may seem desirable for the

current generation of producers and consumers, but at the same time it can block or impose high costs for emerging technologies.

Third, if the primary objective of the government intervention is trying to improve or maximize the total surplus, perfect information is needed. Since there is a probable information asymmetry on behalf of private parties when emerging technologies are involved, a government intervention for example to mandate a standard may cause a significant loss of welfare for both consumers and producers.

The last issue that should to be discussed as a welfare aspect can be deregulation or liberalization of network industries. Although the *deregulation* sounds some neo-liberal associations, the reader of this paper must bear in mind that deregulation signifies introduction of competition into network industries as welfare improving tool.

Because of significance level of economies of scale due to significant fixed costs, natural monopolies arise in network industries. This issue was discussed in the first section. However, starting from 1970s governments began to recognize two major problems with the operation of natural monopolies. First, the service or the product was not improving at the rate of technological change made in these industries. Second, regulators failed to control prices charged because of asymmetric information (Shy 2001, p.7). These recognitions drive governments to introduce competition, in order to improve the social welfare. In the next section one of those industries, telecommunications, will be elaborated.

## 6. Telecommunications as a network industry

Telecommunications, as a network industry, includes most of the network specific features. Network externalities, technical compatibility, standards, positive feedbacks and demand-side economies of scale are clearly observed in

telecommunications. Moreover, one can argue that network externalities can never been observed in other network industries, as much as in telecommunications.

The economic importance of the telecommunications can be sharpened in two ways. First, as declared in a report by the European Commission (1999), the profitability of the top 25 European telecom operators are more profitable than the top 100 European banks. And, the share of the telecom services in GDP is almost 6% in European region (International Telecommunication Union 2005). Second, telecommunications supplies some important infra structure services for the other industries, such as banking, business, etc. Thus, the importance of telecommunications industry must be looked for behind its share in economy, but its externalities for the performance and productivities of other industries.

As understood from its profitability and economic importance, the telecommunications industry seems the fastest growing industry in the world. The rapid technological progress for the sake of the industry and the rapid evolvement of the industry by the effects of rapid technological progress has created a virtuous circle for telecommunications.

Being a major component of the Information Society, the telecommunications industry drives the Information Society throughout the rapid technological progress. More clearly, the internet, data systems of financial markets, information flow of business partners, facsimile, banking services etc. are both ensured through the adaptations of progresses in telecommunications. From another point of view, one can argue that all data transfers around the world in various sectors -voice, information, video, etc.- have become a single industry based on telecommunications.

During most part of the 20$^{th}$ century, telecommunications was mainly based on telephone networks which consisted of two main components: switches and transmission. The switches can be considered as local centers for directing flow of

communication to customers. The transmission unit was composed of wirelines, usually made up copper wires, for carrying voice from customers to customers throughout appropriate switches. The main problem of this network structure was limited capacity. The limited capacity can be understood in two ways: first, limited capacity of voice transmission and second, limited capacity for switching calls. The only way to increase the capacity was based on duplication of network, which was highly costly.

However, technological advance in the last two decades have been a sharp decrease in the cost of transmission and switches. In addition, those advances have also created a convenient environment for a substantial increase in the intelligence of the network (Laffont and Tirole 2000). For instance, fiber optic cables, instead of copper wires, has provided an enormous capacity and speed for the transmission of not only voice, but all digitalized data with substantially low marginal cost. In addition to fiber optic transmission units, some intelligent data transfer systems like ADSL (asymmetric digital subscriber line systems) works on those cables with high performance.

## 7. Competition, regulation and welfare in Telecommunications

Until the end of the last century, general belief for telecommunication services was being natural monopolies, because of strong economies of scale. And in most of the world, except United States, telecommunication services were exploited by public institutions. Moreover, in most countries telecommunications and postal mail services were licensed to a single public monopolist called Public Telephone and Telegraph (PTT).

According to Laffont and Tirole (2000), there are two economic factors for the reform of the public monopolies. First, because of poor incentives of public monopolies for cost reduction and because of price structure determined through

arbitrary cost allocation accounting procedure had exhibited the inefficiency of the incumbent monopolists. Second, technological change has created a major force towards deregulation. For instance, by arising new segments in the industry throughout technological progress, such as wireless connection, new entrants for the markets have become a necessity.

The reforms have been realized generally in two stages. First the incumbent monopolists have begun to be privatized fully or partially. Second, markets of different segments have deregulated or liberalized. However, those privatization and deregulation or liberalization process have required additional regulation en behalf of welfare maximizing.

During the transition phase or right after the reform period, the major problematic issue appears as determination of access charges. Since there are strong network externalities in telecommunications, each firm, which wants to exploit network externalities, has to make interconnections with other networks. This requires some access charges for the desired interconnection.

On the other hand, access charge can also occurred for the use of existing large scale infrastructure of incumbents to provide services in different segments of telecommunications, such as internet service providing, etc. In this situation, to duplicate the existing infrastructure can be too costly and socially undesirable. Thus, that part of the infrastructure indicates a *bottleneck* for the system and a reasonable access charge can allow the provider to operate on the existing infrastructure.

In fact, the determination of access charges can be realized by the negotiations and agreement between the firms. But if the firms do not agree, regulators will have to intervene, in order to some principles for access charges: cost-based charge, usage dependent charge, symmetric or asymmetric charge, non-discrimination rules, publicity of these agreements (European Commission 1999).

But, how one can be sure that agreed access charges are the right prices? According to Armstrong (1998), the role of regulation has not terminated even the firms are agreed. The regulators should always play at least a monitoring role in order to avoid collusive agreements throughout high access charges to prevent entry of new firms. In such cases, the outcome is far from socially desirable level.

The general paradigm for setting access charges suggests that the charges, especially for the telephone networks, must be the marginal cost. But this general paradigm raises a major concern about the structure of the industry. For this issue, Laffont and Tirole (2000) emphasize that marginal cost pricing can be a proper benchmark in a competitive industry. However, networks involving large fixed costs would never be built if their owners were forced to charge only marginal cost.

Other issues for the reformed industry in terms of welfare might be the prices, the quality of services and employment. It is observed that during and after the transition period the market has been restructured. The expected result is downward pressure in prices and costs, and improvement for the quality of the services. In their work Schmidt *et al*. (1999) show that for the 15 European countries there are significant decreases in prices by increasing number of operators. But the effects on employment exhibit a more complex issue.

## 8. Concluding remarks

In this paper, I have tried to point out the nature of network industries. The network industries exhibit different characteristic and do not work like wheat or treasury bond markets. The main network specific features -compatibility, demand-side economies of scale arises from network externalities- have differed those industries from non-network industries.

The most significant issue for the evolvement of network industries appears as technological change. Recent technological developments have restructured most of the network industries. Telecommunications, which is taken as an example in this paper, has showed that being natural monopoly is not a fate for most of the network industries. Furthermore, especially in telecommunications, some segments of the industry exhibit monopolistic competition further than an oligopolistic structure.

Nevertheless, privatization, deregulation or liberalization issues in network industries indicates further problematic issues, such as access pricing for interconnections between networks, and determination of standards for compatibility. These problematic issues suggest rich research fields for further studies in national, regional, even in global level.

**References**


- Armstrong M. (1998) "Network Interconnections in Telecommunications", *The Economic Journal*, Vol.108, pp.545-564.
- Economides N. (1996) "The Economics of Networks", *Journal of Industrial Organization*, Vol.14, No.6, pp.673-99.
- Economides, N. and C. Himmelberg, (1995) "Critical Mass and Network Size with Application to the US Fax Market" Discussion Paper no. EC-95-11, Stern School of Business, NYU. (http://raven.stern.nyu.edu/networks/95-11.pdf)
- European Commission (1999) "Network Industries and Public Service" *European Economy*, Reports and Studies No.4.
- Katz M. L. and C. Shapiro (1985) "Network Externalities, Competition and Compatibility", *The American Economic Review*, Vol.75, No.3, pp.424-40.
- Katz M. L. and C. Shapiro (1994) "Systems Competition and Network Effects", *The Journal of Economic Perspectives*, Vol.8, No.2, pp.93-115.
- Laffont J-J. and J. Tirole (2000) *The Competition in Telecommunications*, MIT Press.
- Schmidt J. H. *et al*. (1999) "Liberalization of Network Industries: Economic Implications and Main Policy Issues" *European Economy,* Reports and Studies No.4, European Commission.
- Shapiro C. and H. Varian (1999) *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press.
- Shy O. (1996) *Industrial Organization: Theory and Applications*, MIT Press.
- Shy O. (2001) *The Economics of Network Industries*, Cambridge University Press.
- Tirole J. (1994) *The Theory of Industrial Organization*, MIT Press.
- International Telecommunication Union (2005) *Europe & CIS, Telecom projections 1995-2005*. (http://www.itu.int/ITU-D/ict/statistics/)