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ASYMMETRIC COMPETITION IN NETWORK SERVICES PROVISION IN THE TELECOMMUNICATIONS SUBSYSTEMS

SUMMARY

The majority of network services provision (postal and telecommunications services, rail transport, air transport, etc.) were traditionally considered as natural monopoly. New scenario of the liberalised national market and "Open Network Provision" require precise and concrete economic evaluation before implementation itself.

This paper considers the methodology for the application of natural monopoly with the concept of cost sub-additivity. It is pointed out that the scale and scope economies, associated with "plant (network) sub-additivity" is not sufficient to justify the monopoly in every service provision in the traffic system and its subsystems. The paper considers and analyses the possible market configuration with various degrees of competition for telecommunication subsystem. The asymmetric competition in the telecommunication subsystem by means of the dominant organisation model has been analysed.

1. INTRODUCTION

Network services provision (such as postal, telecommunications, rail transport, road transport, air transport, etc.) were traditionally treated as natural monopolies. Simple and persuasive explanation is that natural monopoly exists when a single firm can produce the total market demand at lower cost than two or more firms. Conditions under which production by a single firm is a desirable form of market organisation are more rigorously explained by concepts of scale and scope economies[1]. More generic explanations are related to the concept of cost subadditivity[2].

Inefficiency and inflexibility of the old public monopolies led to global (politically driven) trend of "re-regulation" (deregulation) and liberalisation in the last decade. "Open Network Provision" and free trade of services are the central postulates of the Treaty of Maastricht (1992) and other European Commission documents (White Book, Green Paper II/1994, etc.). Practical regulation and policy decisions reflect more what was politically feasible than what was analytically desirable. However, competition in network services is not "laissez-fair" minded in simplistic sense and it is not cost-less process.

The major debate now relates to network service competition in telecommunications sector. The European Union (EU) has decided to open the infrastructure and voice services to competition by January 1, 1998. With liberalised "Value-Added Services" (VAS), this new re-regulation opens the gates to new telecom operators and service providers who see a business opportunity in supplying different services for customers.

National packet of regulation policy and measures for restructuring old monopolies, require careful economical evaluation. The cost and effects must be evaluated within consistent time and sector boundaries taking into account global (or European) trend toward market-oriented "open network provision". Welfare losses resulting from insufficient economic analysis and inadequate tariff policy are measured by billions (in Germany 5 billion DM for 10 years only for Value Added Services)[3].

A number of sources discuss economies of scale in transmission, switching and planning, based on engineering cost analysis or simulations. Both the technical and economic characteristics of telecommunication network and services are surveyed in[4]. There are several reports and econometric studies in which usable models of telecommunications industry are presented. In this paper, the concrete options for competition in network (telecommunications) services from the economic perspective are discussed.

The main thesis is that plant (technical) subadditivity is insufficient to justify the existence of a firm monopoly for all services, because PTO has "organisational diseconomies". Organisational diseconomies are closely related to managerial economics and undeveloped marketing-management capacities in PTO. Any firm or its division (business unit) actually exist only if they have relative advantages in organising and co-ordinating inputs and producing outputs.

After formally describing the natural monopoly, we focus on the evaluation of possible competition options in providing network services using the introduced economical terms. In the conceptual experiment we consider the model of asymmetric competition → dominant firm model, which can be relevant for network provision in transport and telecommunications. A test for plant and firm subadditivity can be based on comparison of the cost of producing demanded outputs before and after entering the market.

2. THE DESCRIPTION OF NATURAL MONOPOLY

Natural monopoly is commonly defined as the one that exists when a single firm can produce the total market demand at lower cost than two or more firms. Most authors agree that natural monopolies are primarily industries in which there are persuasive economies of scale or decreasing average cost. "Destructive competition" is related to natural monopoly, but precise relationship between them is not derived.

For a more formally description of natural monopoly we use the concept of subadditivity (cost subadditivity) as a more generic concept than scale and scope economies. To test subadditivity of overall network cost, we can compare the cost of a single supplier with the cost of having two or more suppliers.

Let $q=\left(q^1,\ldots,q^r\right)$ represent a vector of outputs in a particular network services market, and let C(q) represent the monetary value of physical, technological and organisation inputs that are required to produce q services. In the first approximation market structures are associated with relative cost of producing an output q with a single firm (public enterprise or corporation) or with several or many firms.

Statement 1. If $q^1,\ldots,q^r$ are output vectors whose sum is equal to q, then a single firm provides a more effective structure than a multi-firm market if there is subadditivity of costs:

$$C(q)<C\left(q^1\right)+\ldots+C\left(q^r\right) \tag{1}$$

assuming that all firms in the market have approximately the same cost function C.

Output vector q may be a single output or many outputs. If q represents a vector of outputs of a whole industry or sector (like telecommunications services, postal services, railway services, air transport services, etc.) inequality would hold if and only if that sector (branch) is a natural monopoly. Subadditivity of cost is closely related to the concept of economies of scale, economies of scope and economies of joint production. Formal theory and rigorous descriptions of these concepts are discussed in [1].

Scale and scope economies (and diseconomies) in transport and telecommunications systems, are generally related to cost function which describes technology of the firm. Plant subadditivity is related to pure technical aspects of production, and it can be measured through engineering cost analyses.

In formal description we can say that economies of scale exist for a given cost function C and output q if:

$$C(\lambda q)<\lambda C(q) \tag{2}$$

for all λ such that:

$$1<\lambda\leq 1+\varepsilon$$

where ε is a small positive number.

If we divide both sides of (2) by λq we have:

$$\frac{C(\lambda q)}{\lambda q}<\frac{C(q)}{q} \tag{3}$$

which can be interpreted as average cost C(q)/q. They are declining if there are economies of scale at q.

Illustration of economies and diseconomies of scale are given in Figure 1. We assume that economies of scale exist at every output $q<q_o$, and diseconomies of scale exist at every $g^*>g_o$.

For the output $q>q_o$ it can be effective to allow a second firm to produce same or similar goods (services), if joint subadditivity of cost exists. In that case for all outputs $q>q^*$ costs are lower with two (or more) firms than with one.

Subadditivity depends generally on the form of the cost function and the total output which is desired. If C is strictly subadditive for all $q<q_o$ we can write the condition for subadditivity more compactly as:

$$C(y)<C(x)+C(y-x) \quad \text{for } 0\leq y\leq q \text{ and } 0<x<y \tag{4}$$

If inequity (4) can be verified for all $y\leq q$, then inequality:

$$C(q)<\sum_{i=1}^{r} C\left(x^i\right) \tag{5}$$

also follows for q. If q is the largest possible demand in the sector and inequality (4) holds, then C is strictly subadditive and sector (branch) is a natural monopoly (unconditional on q).

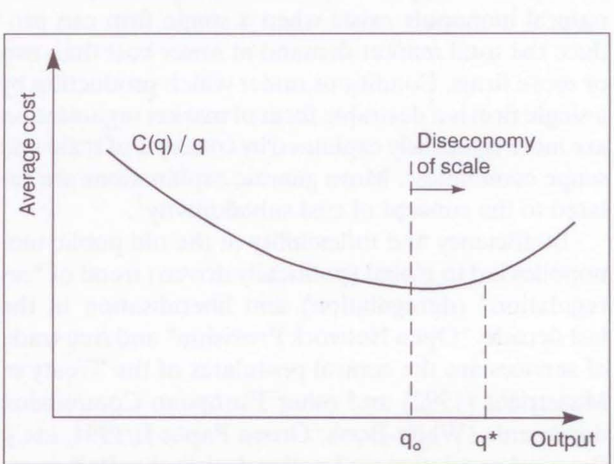

Figure 1 - Economies and diseconomies of scale

For evaluating natural monopoly and effective market structure, next propositions are very important. C is strictly concave if:

$$C\left[\delta x+(1+\delta)y\right]>\delta C(x)+(1-\delta)C(y)$$
$$\text{for} \quad 0<\delta<1 \qquad (6)$$

and strictly convex if:

$$C\left[\delta x+(1+\delta)y\right]<\delta C(x)+(1-\delta)C(y)$$
$$\text{for} \quad 0<\delta<1 \qquad (7).$$

If C is a differentiable function, then strict concavity of C is equivalent to $d^2C/dq^2<0$ and strict convexity is equivalent to $d^2C/dq^2>0$. Because dC/dq is the marginal cost of output, concavity is equivalent to declining marginal cost. Convexity is equivalent to increasing marginal cost.

Statement 1. Subadditivity is a more general concept than economies of scale (falling average cost) or falling marginal cost (concavity). Both, economies of scale and concavity of cost function are sufficient, but not necessary for subadditivity.

Subadditivity in a multi-product firm is much more complex than single output subadditivity. However, for more useful description we must consider multiple outputs firm and place the concept of subadditivity in the context of equilibrium theory (partial or general).

For more basic description of technology and better understanding of the cost function, we introduce the production possibility set Y. Outputs are represented by a vector $y=(y_1,...,y_n)$. Production of m-outputs involves transformation of inputs $x=(x_1,...,x_m)$ into outputs, where inputs are: labour, capital, materials, managerial capabilities, etc.

Definition 1. The production possibility set Y is a set in (m+n) dimensional space consisting of feasible production plans:

$$Y=\{(y,x): \text{y can be produced from x}\}$$

We assume that natural monopolist is a "price-taker" in the markets for inputs. For input prices represented by the vector $v=(v_1,...,v_m)$ the cost function may be defined as the last costly method of producing y. We can say that the cost function is formally defined by:

$$C(y)=\text{Min}\{v\,x \text{ for x such that} (y,x) \text{ is in Y}\}$$

Multi-product subadditivity can be defined in the same form as single output subadditivity:

Definition 2. Multi-product cost function C is subadditive if:

$$C(y)+C(y')\geq C(y+y')$$

for any output vectors y and y'.

If input markets are not competitive, cost function cannot be defined as in definition (equation) (2), then the appropriate definition introduces the concept of "superadditivity".

Definition 3. A production set Y is superadditive if for every pair of input-output bundles (y,x) and (y',x) which are contained in Y, it is true that (y+y', x+x') is contained in Y.

Subadditivity in a multi-product context with production possibility set Y, can be used in defining scale economies, scope economies and economies of joint production.

Statement 2. There are economies of scale (associated with Y) if for every input-output combination (y,x) in Y and every $\lambda\geq1$ the pair (λy, λx) is in Y.

For single output production, scale economies are equivalent to decreasing average cost, however, with multiple output production this simple equivalence doesn't exist. The condition sufficient for subadditivity in a multi-product context can be explained by "economy of joint production". For measuring the economies of joint production, we can apply "economies of scope".

Definition 4. Cost function C has economy of scope if:

$$C(y)+C(y')\geq C(y+y')$$

whenever y and y' consist of disjoint outputs.

Scale and scope economies together are not sufficient for general subadditivity. However, one generic condition known as "cost complementary" is sufficient for subadditivity. Cost complementary holds if an increase in one output tends to reduce the incremental cost of producing other outputs.

Another measure of the economies of joint production is the "trans-ray convexity", which is closely related to the property of "quasi-convexity". Formal definition and explanation of "trans-ray convexity" and "quasi-convexity" is provided in[5]. The most important conclusion is that (either) trans-ray convexity or quasi-convexity in combination with economies of scale is sufficient for subadditivity.

The terms "plant subadditivity" and "firm subadditivity" were used to describe two different aspects of subadditive cost function. Plant subadditivity reflects strictly technological aspects of subadditivity. It is focused on the technology of the production and network infrastructure. Firm subadditivity reflects the organisational advantages of single firm. It exists when the organisation of productive activities within a firm is more efficient than organisation through the competitive market.

3. OPEN NETWORK PROVISION AND POSSIBLE COMPETITION OPTIONS

The EU concept of Open Network Provision (ONP) is strongly market-oriented. ONP directives and regulations introduce international free trade in the most of network services where this is technologically possible. Problems of network's interconnection and interoperability produce "demand" for public standardisation and co-ordination of standard setters. Regulation and standardisation policy must reflect economic considerations (desirability), together with technological feasibility and political acceptability. Welfare losses resulting from insufficient economical analysis and inadequate policy are measured in billions of dollars per year.

Different market configurations and cost function (of a supplier or demander) can be relevant for open network (service) provision. We can assume that the cost function of a supplier in a network market has one of typical forms with corresponding market case:

1) "constant cost" function (in which case many suppliers will appear on the market);
2) "decreasing cost" (only one firm is effective solution); as long as entry and exit are free and unconstrained, we have the case of "contestable natural monopoly" (with bidding procedure or another solution);
3) decreasing cost in combination with "sunk cost" (entry and exit are not free and cost-less process);
4) different cost function for oligopoly cases.

In practice, open network provision and international competition were first introduced in air transport and some segments of road transport. More recently, international courier services compete with public post offices and with private retailers on the international level. Many telecommunications services are provided internationally by private and public global companies.

In some network services international competition is still less negligible. For example in railroads: French TGV-trains must not run on German rails and German ICE-trains are not allowed to provide services on their own account on the French rail network. In other cases, international trade in inhibited by incompatibility of technical standards and network incompatibilities.

For more evaluation, we will consider actual options for telecommunications services. ONP with "Green Paper" (I, II) and European Union Directive promote free trade in services with defined technical standards and compatibility. The EU has decided to open the infrastructure and voice services to competition by January 1, 1998. This "re-regulation" opens the gates for new telecom network operator and service providers who see a business opportunity in supplying different services for business and residential customers.

The main options for telecommunications services competition are:

1) Unrestricted competition in all kinds of basic (bearer) service and tele-services (telephony, telex, facsimile, etc.);
2) Unrestricted competition for all services, except telephony;
3) Monopoly on basic services and competition in value added services;
4) Monopoly on basic services and some value-added services.

These four basic options for competition in services cannot be freely combined with models for competition on network side. The logical solution is not to formulate separate competitive models for network and services, but to allow effective competition in telecommunications services thus involving different network facilities and information processing applications.

Several economic contributions discuss these or related problems[6]. Special economic groups are formed in many countries (Bell-Labs Economic Analysis Group; Long Range Study Group of British Telecom, etc.). Public telecom operator's (PTO) academic staff consisting mainly of engineers and lawyers were to deal with deeply economic arguments, but they accepted "global trends".

The most economic research of natural monopoly and network services competition are focused on evaluation of scale economies and scope economies. These findings confirmed the presence of increasing returns to scale in classical telecommunications industry → telephone network and basic telephone services. Empirical studies of telephony cost have general consensus that scale economies exist, but estimates are different in range (from 1,04 do 1,20 and greater when technological changes are included).

Several kinds of value-added services (VAS) are characterised by economies of scale that differ in degree and structure. For VAS based on leased lines, economies of scale result from the effects of traffic concentration. The greater the traffic implicate the more efficient use of leased lines and switching capacities incorporate in service provision.

Second economies of scale result from the size of the switching facilities and intelligence unit required to provide other VAS such as mailbox, on-line data bank services, information processing services, etc.

The ability to perform additional functions at the same time and with little incremental cost enables the PTOs to use their basic network facilities to produce value-added services. The economies of scope result from:

- common use of network facilities for basic services and VAS;
- technological know-how for the construction of network and services;
- the related technological marketing of VAS and basic services.

Economies of scope are smaller in cases when PTO provides the value-added services in a special network. In the cases of new "multi-services" network (ISDN, GSM), economies of scope are substantial. PTO can provide value-added services in combination with its basic services with incremental cost that is lower than cost for independent provider.

In many cases economies of scope exist between VAS and some non-telecommunications activities (banks, publishers, software producers, etc.). For example, publishers or software producers have competitive advantages in offering some telematics services that use their information resources. The incremental cost of producing such VAS is much greater than the cost of providing the same VAS on a stand-alone basis.

4. ASYMMETRIC COMPETITION DESCRIBED BY THE DOMINANT FIRM MODEL

We will consider the dominant firm model which can be relevant for modelling asymmetric competition in network services providing. These models of firm behaviour are closely related to the competition (market) characteristics, and they can formally explain the process such as:

- price and output determination,
- entry barriers,
- product differentiation, etc.

Asymmetric results from the fact that the dominant firm has more market power than its competitors (in the domestic market). The dominant firm position can arise from the fact that it has a significant cost advantage or there are some significant barriers to entry. In many practical situations, competitive firms may be able to serve the market segments that dominant firms find "unprofitable" or unattractive.

The dominant firm model is illustrated in Figure 2. This model presupposes that dominant firm is the price setter and each of the small firms is a price taker. Output is associated with price. Another "non-price instruments" (→Marketing-mix) we should treat separately. Like any business firm, the dominant firm is assumed to choose price and quantity to maximise revenue (profit).

In the illustrated model, the total demand curve is given by DD, the marginal cost curve for dominant firm is MC_d, the summation of the supply curves of the followers is S_f (S_{fringe}). Followers produce up to the output level where their individual marginal cost just equals the price. The leader's demand curve (P_1BD) can be derived by subtracting the followers supply (S_f) from the total demand (DD) at each price:

$$P_1\,B\,D = D\,D - S_f$$

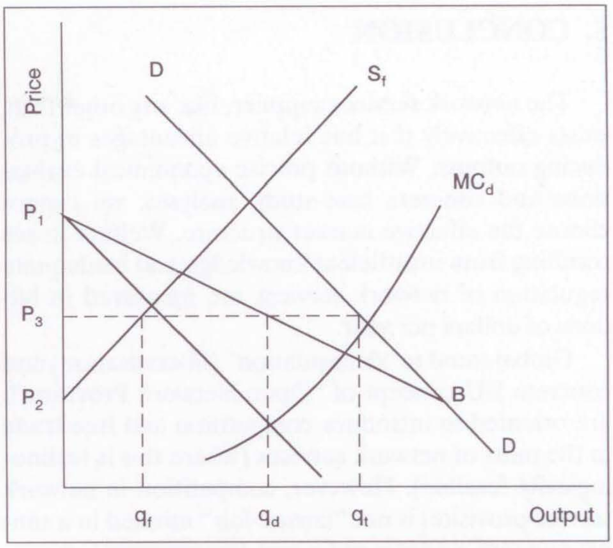

Figure 2 - The Dominant Firm model

For instance, if the price were set at P_2 or below, none of the followers would be willing to produce any output; if the price were set at P_1, the followers would (theoretically) supply the entire market. Intermediate points on the dominant firms demand curve can be obtained by subtracting S_f from DD at the respective price.

With this information, we can determine price and output for the dominant firm, the followers, and the sector (industry). The dominant firm model produces an output level Oq_d and price P_3 (up to the point at which its marginal cost MC_d equals marginal revenue). With the price set at P_3, the followers firms will supply q_dq_t.

For a more realistic description of the underlying structure of a sector, the more dynamic approach is necessary. Michael E. Porter elaborated "structural dynamism" by sets of forces that shift over time[7]:

- entry conditions,
- product/services substitution,
- the bargaining power of buyers,
- the bargaining power of suppliers,
- rivalry among competition.

He has studied many competitive situations and has derived bas basic conditions for a successful "attack" on a dominant firm. The example of America West Airlines (AWA) illustrates the successful introduction of a no-frills airline that has taken away business from a dominant airlines firm in the western half of US. Stability of airline industry existed because Civil Aeronautics Board (CAB) regulated the industry, controlled airfares and completely determined routes and entry conditions. In this example, "deregulation" makes possible for airlines (such as AWA) to innovate and provide customers with greater choice.

5. CONCLUSION

The network services supplier, like any other firm, exists effectively if it has relative advantages in producing outputs. Without precise economical evaluations and concrete case-study analyses, we cannot choose the effective market structure. Welfare losses resulting from insufficient knowledge and inadequate regulation of network services are measured in billions of dollars per year.

Global trend to "deregulation" (liberalisation) and concrete EU concept of "Open Network Provision", are oriented to introduce competition and free trade in the most of network services (where this is technologically feasible). However, competition in network service provision is not "laissez-fair" minded in a simplistic sense, and it is not a cost-less process.

For deeply economic evaluation and effective market-oriented regulation, we must know the form of cost function for particular network service. Classical tests for economies of scale and economies of scope must be enhanced by the effects (economies) associated with new technologies, structural dynamism and inter-temporal relations.

Several difficulties are inherent in measuring economies of scale and in deriving regulative (policy) conclusions from these findings. In the most econometric studies, aggregated output measures are used and an estimate of system-wide economies of scale is represented by scale elasticity. These studies do not give reliable measurement of cost functions (multi-product cost function); effects of endogenous technological changes, organisation diseconomies, etc. The application of multiple output production function in some recent studies is a significant advance over earlier studies, but it is not sufficient for definitive test of plant and firm subadditivity.

In general, cost subadditivity exists when a single firm can produce a given output or sets of outputs at lower cost than two or more firms. Direct test for plant and firm subadditivity requires comparison of the cost of producing the demanded output in a single firm with every conceivable alternative with two or more firms. Alternatively, it is a comparison of the industry cost before and after entering the market with a dominant firm and many small competitors. The dominant firm model and the model of "potential competition" (franchise bidding, etc.) give some usable insights in practical regulation decisions.

We cannot give definitive answer which network service (market) is a natural monopoly without detailed analyses of the technology and demanded characteristics in the concrete environment. The purpose of this paper is limited only to mark the problem and suggest indispensable economical analyses before policy makers do their jobs.

SAŽETAK

ASIMETRIČNA KONKURENCIJA U PRUŽANJU MREŽNIH USLUGA U TELEKOMUNIKACIJSKOM PODSUSTAVU

Pružanje mrežnih usluga u svim vidovima prometne djelatnosti tradicionalno je razmatrano kao prirodni monopol. Liberalizacija nacionalnog tržišta i koncept "Otvorene mreže" u gospodarstvu zahtijeva preciznu i pažljivu ekonomsku procjenu prije same primjene..

U radu autori analiziraju metodologiju za primjenu prirodnog monopola s konceptom subaditivnosti troškova. Utvrđuju da je ekonomija veličine i ekonomija područja djelovanja povezana s "tehničkom subaditivnosti", nije dovoljna za opravdanje monopola u ponudi svih usluga u prometnom sustavu i njegovim podsustavima. Razmotreni su i analizirani mogući oblici tržišta s različitim utjecajem na telekomunikacijski podsustav. Analizirana je asimetrična konkurencija u telekomunikacijskom podsustavu modelom dominantnog organizacijskog oblika.

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