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NATURAL MONOPOLY AND ASSYMETRIC COMPETITION IN NETWORK SERVICES PROVISION

PRIRODNI MONOPOL I ASIMETRIČNA KONKURENCIJA U PRUŽANJU MREŽNIH USLUGA

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Summary

The most network services provision (postal&telecommunications services, rail transport, air transport, etc.) were traditionaly treated as a natural monopoly. New scenario of liberalized national market and "Open network Provision", require precise and concrete economic evaluation before implementation.

The present paper consider formal methodology for natural monopoly evaluation with the concept of cost subadditivity. We point out that scale and scope economies, associated with "plant (network) subadditivity", is insufficient to justify the firm monopoly for all service provision. Possible market configuration with various degrees of competition for concrete (telecommunications) branche are discussed.

Key words: Network Services, Scale and Scope Economies, Cost Subaditivity, Assymetric Competition, Marketing-Management Capabilities

Sažetak

Pružanje mrežnih usluga (poštanskih i telekomunikacijskih usluga, željezničkog prijevoza, zračnog prijevoza, i dr.) tradicionalno je tretirano kao prirodni monopol. Novi scenarij liberalizacije nacionalnog tržišta i koncept "Otvorene mreže" zahtijeva preciznu i pažljivu ekonomsku evaluaciju prije implementacije.

U radu je dana formalna metodologija za evaluaciju prirodnog monopola s konceptom subaditivnosti troškova. Naglašeno je da ekonomija veličine i ekonomija područja djelovanja, asocirana s "tehničkom subaditivnosti", nije dovoljna za opravdanje monopola u ponudi svih usluga. Razmotrene su moguće konfiguracije tržišta s različitim stupnjem kompeticije za konkretnu granu (telekomunikacije). Opisana je asimetrična konkurencija modelom dominantne firme.

Ključne riječi: mrežne usluge, ekonomija veličine i područja djelovanja, subaditivnost troškova, asimetrična konkurencija, marketing-management sposobnosti.

1. Background
Pregled

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

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

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

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National packet of regulation policy and measures for restructuring old monopolies, require a 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 losess resulting from insufficient economic analysis and unadequate tariff policy is measured by billions (in Germany 5 billions DM for 10 years only for Value Added Services).[3]

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 a usable models telecommunications industry are presented. In this paper, w discuss concrete options for competition in network (telecommunications) services-form the economic perspective.

The main thesis is that plant (technical) subadditivity is insufficient to justify the existance of a firm monopoly for all services because PTO has "organizational diseconomies". Organizational diseconomies are closely related with managerial economics and undevelopment marketing-management capacities in PTO. Any firm or its division (business unit) effectively exists only if it has a relative advantages in organizing and coordinating inputs and producing outputs.

After formal description of natural monopoly, we are focused on evaluation possible competition options in providing network services using introduced economical terms. In the conceptual experiment we consider model of assimetric 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 wntry in a market.

2. Formal description of natural monopoly
Formalni opis prirodnog monopola

Natural monopoly is commonly defined to exist 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 with natural monopoly, but precise relatinship between them is not derived.

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

Let $q = (q^1,..., q^r)$ represent a vector of outputs in a particul network services market, and C(q) represent the monetary value of physical, technological and organization 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 some or many firms.

Constatation 1. If $q^1,...,q^r$ are output vector which sum is equal to q, then a single firm is more effective structure than a multifirm market if a subadditivity of costs exist:

(1) $C(q)\ C(q^1) + ... + C(q^r)$

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

Output vector q may be a single output or many outputs. If q represents a vector of outputs of whole industry or sector (like telecommunications services, postal services, railway services, air transport services, etc.) inequality would hold if and only if that sector (branche) 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.

Scale and scope economies (and diseconomies) in transport and telecommunications systems, are generaly related with cost function which describe technology of the firm. Plant subadditivity is related with 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:

(2) $C(\lambda q) < \lambda\ C(q)$

for all λ such that:

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

where ε is a small positive number.

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

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

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

Ilustration of economies and diseconomies of scale are given on 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 allowed second firm to produce same or similar goods (services), if joint subadditivity of cost exist. In that case for all outputs $q>q^*$ cost are lower with two (or more) firms, than with one. Mode $q-q_o$ is the inflesion made.

Subadditivity depends in general 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 condition for subadditivity more compactly as:

(4) $C(y) < C(x) + C(y-x)$ for $O \leq y \leq q$ and $O < x < y$

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

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

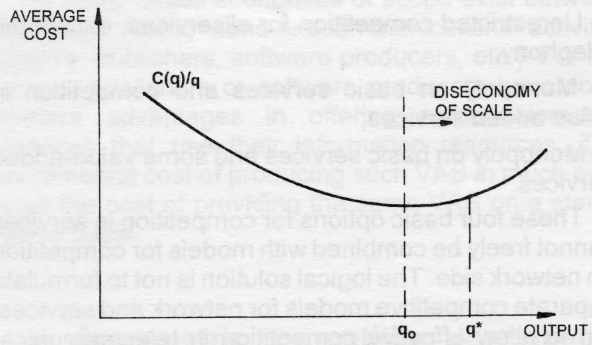

Figure 1. Economies and diseconomies of scale are given
Slika 1. Prikazane su ekonomija i disekonomija veličine

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 (branche) is a natural monopoly (unconditional on q).

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

(6) $C[\delta x + (1+\delta)y] > \delta C(x) + (1-\delta)C(y)$ for $O<\delta<1$

and strictly convex if:

(7) $C[\delta x + (1+\delta)y] < \delta C(x) + (1-\delta)C(y)$ for $O<\delta y1$.

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

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

Subadditivity in a multiproduct 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: labor, capital, materials, managerial capabilites, etc.

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

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

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:

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

Multiproduct subadditivity can be defined in the same form as single output subadditivity:

Definition 2. Multiproduct 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, a cost function cannot be defined as in definition (equation) (2), then the appropriate definition introduce 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 atrue that (y+y', x+x') is contained in Y.

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

Constatation 2. There are economies of scale (associated with Y) if for every input-output combination (y,x) in Y and every $\lambda \geq 1$ the pair $(\lambda y, \lambda x)$ 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 conditions that are sufficient for subadditivity in a multiproduct context can be explained by "economy of joint production". For measuring the economies of joint production, we can applie "economies of scope".

Definition 4. A cost function C has economy of scope if:

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

whenever y and y' consists 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 outputs 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 "quasiconvexity". Formal definition and explanation of "trans-ray convexity" and "quasiconvexity" is provided in.[5] The most important conclusions is that (either) trans-ray convexity or quasiconvexity 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 a subadditive cost function. Plant subadditivity reflect strictly technological aspects of subadditivity. It is focused on the technology of the production and network infrastructure. Firm subadditivity reflects the organizational advantages of single firm. It exist when the organization of productive activities within a firm is more efficient than organization through the competitive market.

3. Open network provision and possible competition opions
Pružanje usluga otvorene mreže i moguće konkurekcijske opcije

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 it is technologicaly possible. Problems of network's interconnection and interoperability produce "demand" for public standardization and coordination of standard setters. Regulation and standardization policy must reflect economic sonsiderations (desurability), together with technological feasibility and political acceptability. Welfare losses resulting from unsufficient economical analysis and unadequate policy is measured in billions 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 on 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 sollutions;

3) decreasing cost in combination with "sunk cost" (entry and exit are not free and costless process);

4) different cost function for oligopoly cases.

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

In some network services international competition is still smaller 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 another cases, international trade is inhibited by incompatibility of technical standards and network incompabilites.

For more evaluation, we will considere actuall 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. EU has decided to open to competition infrastructure and voice services 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 service for business and residential customers.

the main options for telecommunications services competition are:

1) Unrestricted competition in all kinds of basic (bearer) service and teleservices (telephony, telex, telefax, etc.);

2) Unrestricted competition for allservices, except the 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 freely be 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 involves different network facilities and information processing applications.

Several economic contributions discuss these or related problems.[6] Specially 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 was enabled to deal with deep economic arguments, but they accept "global trends".

The most economic researching 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 characterized by economies of scale that differ in degree and structure. For VAS based on leased lines, economies of scale results from the effects of traffic concentration. The greater traffic implicate the more efficien use of leased lines and switching capacities incorporate in service provision.

Second economies of scale result from the size of the switching facilities and inteligence 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 the little incremental cost, enables the PTO's 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 case when PTO provides the value-added services in a special network. In the cases of new "multiservices" network (ISDN, GSM), economies of scope are substantial. PTO can provide a vallue-added services in combina-

tion 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 none-telecommunications activites (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 in much over than the cost of providing the same VAS on a stand-alone basis.

4. Assymetric competition described by dominant firm model
Asimetrična konkurencija opisana modelom dominantne tvrtke

We will consider dominant firm model which can be relevant for modelling assimetric competition in network services provoding. these models of firm behavior are closely related with the competition (market) characteristics, and they can formaly explain process such as:

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

Asymetric results from the fact that the dominant firm has more market power than its competitors (in domestic market). Dominant firm position can arise from the fact that it has a significant cost advantage or some significant barriers to entry exist. In many practical situations, competitive firms maybe able to serve market segments that dominant firms find "unprofatible" or unatractive.

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

In the illustrated model, the total demand curve is give gy 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 equal price. The leader's demand curve (P_1BD) a can be derived by subatracting the followers supply (S_f) from the total demand (DD) at each price:

$$P_1BD = DD - S_f$$

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 (theoreticaly) supply the entire market. Intermediate points on the dominant firms demand curve can be obtained by subatracting S_f from DD at the respective price.

With this information, we can do price and output determination for the dominant firm, the followers, and

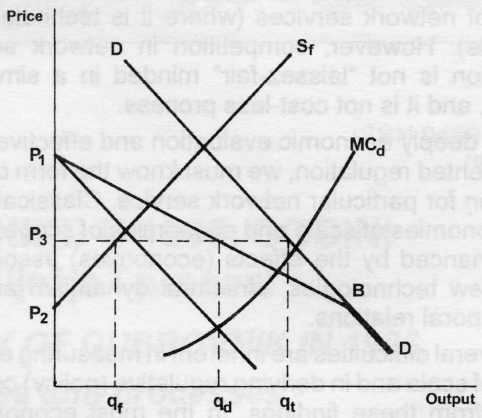

Figure 2. The Dominant Firm model
Slika 2. Model dominantne tvrtke

the sector (industry). The dominant firm model produce at output level Oq_d and price P_3 (up to the point at which its marginal cost MC_d equal marginal revenue). With the price set at P_3, the followers firms will supply O_{gf} ($O_{gf} + O_{gd} = O_{gt}$).

For more realistic describing the underlaying structure of a sector, the more dinamic approach is necessery. Michael E. Porter elaborate "structural dynamism" by sets of forces that are shifting over time[7]:

- entry conditions,
- product/services substatution,
- 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 success full introduction of a no-frills airline that has taken away business from a dominant airlines firm in the western half of US. The 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" make possible for airlines (such as AWA) to innovate and provide customers with greater choice.

5. Conclusion
Zaključak

Network services supplier, like any other firm, effectively exists if it has relative advantages in producing outputs. Without precisely economical evaluations and concrete case-study analyses, we can not choice effective market structure. Welfare losses resulting from unsufficient knowledge and unadequate regulation of network services are measured in billions dollars per year.

Global trend to "deregulation" (liberalization) and concrete EU concept of "Open Network Provision", are oriented to introduce competition and free trade in the

most of network services (where it is technologicaly feasible). However, competition in network service provision is not "laissez-fair" minded in a simplistic sense, and it is not 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 intertemporal 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 systemwide economies of scale is represented by scale elasticity. These studies don't give reliable measurement of cost functions (multiproduct cost function); effects of endogenous technological changes, organization 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 single firm can produce a given output or sets of outputs at lower cost than two or more firm can. A direct test for plant and firm subadditivity requires a comparison of the cost of producing a demanded output in a single firm with every concaivable alternative with two or more firms. Alternatively, it is a comparation of the industry cost before and after entry in a market with a dominant firm and many small competitors. Dominant firm model and model of "potential competition" (franchise bidding, etc.) give some usable insight for practical regulation decisions.

We can not give definite answer which network service (market) is 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 problem and suggest indispensable economical analyses before policy makers do their jobs.

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Notes
Bilješke

[1] L.P. Pepers and D.G. Bails: Managerial economics, Prentice-Hall Int. Englewood Cliffs, New Jersey, 1987, pp. 432-434.

[2] W.W. Sharkey: The Theory of natural monopoly; Cambridge University Press, Cambridge, 1986, pp. 180-182.

[3] G. Pfeiffer and B. Wieland: Telecommunications in Germany - An economic perspective; Springer-Verlag, Berlin Heidelberg, 1990, pp. 50-52

[4] W.W. Sharkey: The Theory of natural monopoly, Cambridge University Press, Cambridge, 1986, pp. 183-184.

[5] W.W. Sharkey: Ibidem, pp. 180-184.

[6] C.B. Blankart and G. Knieps: Market-oriented Open Network Provision, Information Economics and Policy, 20, 1995, 7, pp. 48-54.

[7] M.E. Porter: Competitive Advantage; Free Press, New York, 1985, pp. 270-276.

Literature
Literatura

1) Books

[1] W. Baumolli, J. Panzar and R. Willig: Contensrable markets and the theory of industrial structure, Harcourt B. Jovanovich, New York, 1982.

[2] I. Bošnjak: Technological (High-Tech marketing) (Conception and implementation in telecomunication system), Faculty of Transport and Traffic Engineering, Zagreb, 1996.

[3] Ž. Radačić and D. Šimulčik: Economics of Traffic System, Faculty of Transport and Traffic Engineering, Zagreb, 1995.

[4] D. Šimulčik: Economics of post and telecommunication Traffic, Faculty of Transport and Traffic Engineering, Zagreb, 1996.

2) Articles

[1] N.C. Bursey: Bus Stations and Deregulation, Transport Research, Vol. 25, 195, pp. 75-86.