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THE TELECOMMUNICATION MARKET: A SURVEY OF THEORY AND EMPIRICS

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The Telecommunication Market: A Survey of Theory and Empirics*

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1. Introduction

The market for telecommunication has gone through some major changes during the two latest decades. The changes are due to deregulation and rapid technological progress. More than ever, the task of studying the telecommunication market has been considered important by economists. The objective of this survey is to introduce recent economic literature of relevance to the telecommunication market. I have chosen to only include articles/books published in a scientific economic journal or being of comparable quality. The reader is assumed to have some knowledge of economics in general, but not of telecommunication.

The empirical literature can be divided into mainly three categories: Articles (i) discussing the natural monopoly hypothesis, (ii) estimating various demand functions and elasticities, and (iii) discussing deregulation. The two first categories have a much longer and more prominent history than the third, which is only a decade old. Deregulation has made it harder to obtain cost and demand

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data which in turn makes work within the two former fields more difficult. At the same time deregulation gave rise to new questions. Deregulation also provided some data not available in the pre-deregulation era. Hence, the latter field is the most rapidly growing one. I will discuss these three areas and try to provide a theoretical foundation together with some historical perspectives. Unfortunately, almost all empirical literature concerns the U.S. or Canada. The few Swedish studies are of course accounted for.

Deregulation has also made the understanding of how dominant firms deter entry more important. The last section of this survey briefly discusses some main findings from the field of industrial organization.

2. Natural Monopoly

The notion of natural monopoly is intimately connected with increasing returns to scale which in turn is connected with fixed costs. Intuitively, an (unregulated) industry is said to be a natural monopoly if no more than one single firm can earn non-negative profits.[1] The telecommunication industry, with its large investments in physical facilities and low marginal costs, is often considered a natural monopoly. The common definition of a natural monopoly is, however, not made from profits but from the properties of the industry's cost function and from the viewpoint of a well-informed social planner.

2.1. A Single Good Industry

The case of a single good industry is straightforward and provides some intuitive understanding which is useful in the multiple good case. Let $q^1, ..., q^n$ be different production quantities of a homogeneous good and let $C(q^i)$ be the cost of producing q^i. The production function is subadditive if $\sum_{i=1}^{n} C(q^i) > C(\sum_{i=1}^{n} q^i)$. Subadditivity implies that it is cheaper to produce different quantities jointly than separately. A subadditive production function implies natural monopoly. Large fixed costs, as mentioned above in the telecommunication example, may induce subadditivity. The fixed cost does not have to be duplicated if production takes place in one firm.

[1] Tirole[67] page 20.

2.2. A Multiproduct Industry

Just as in the single good case an industry is a natural monopoly if its cost function is subadditive. Unfortunately, the simplicity of the single good case does not carry over. On the contrary, economies of scale is neither sufficient nor necessary for subadditivity in the multiple product framework.[2] It is also possible to show that economies of scale and scope do not suffice.[3] Thus, there is a need for stronger conditions in order to guarantee natural monopoly.

Let I be the product-space of an industry and let subindex denote product, i.e. q_i is the quantity produced of good $i \in I$. $\mathbf{q} = (q_1, ..., q_n)$ is the output vector and the incremental cost of product i, $IC_i(\mathbf{q})$, is the change in the firm's total cost when introducing i at level q_i holding every other quantity fixed or, alternatively, the cost reduction if the firm stops producing q_i. The average incremental cost of i is the incremental cost divided by q_i. Let $\mathbf{q}_i' = (q_1, ..., q_i', ..., q_n)$ and $\mathbf{q}_i'' = (q_1, ..., q_i'', ..., q_n)$, then the average increment cost, $AIC_i(\mathbf{q})$, is decreasing through $\mathbf{q}$ if $AIC_i(\mathbf{q}_i') < AIC_i(\mathbf{q}_i'')$ for all $0 \leq q_i'' \leq q_i' \leq q_i$. Clearly, if the objective is to minimize industry cost and $AIC_i(\mathbf{q})$ is decreasing then all production of $i \in I$ should be consolidated within one single firm.

A multi-product cost function is subadditive at $\mathbf{q}$ if it exhibits economies of scope at $\mathbf{q}$ and the average incremental cost is decreasing through $\mathbf{q}$ for each $i \in I$. If each good should be produced in one firm and economies of scope is present, then the production of all goods should be gathered together. Hence, the industry is a natural monopoly.

Another sufficient condition for a cost function to induce natural monopoly at some point is strict quasiconvexity of the cost function.

2.3. Empirics

Almost all empirical research have used U.S. data or data from Bell Canada. Telecommunication was early recognized to be a multiproduct industry but unfortunately no study before the early 1980s applied the multiproduct framework. The importance of multiproduct studies was accentuated by the antitrust suit against Bell System starting in 1974. The U.S. Department of Justice aimed to

[2]The following theoretical summary follows Panzar[53].

[3]Economies of scope: Economics of scope is present if it is cheaper to produce different products together than separately. Let q_1 and q_2 be quantities of two different products, then economies of scope is said to be present if $C(q_1, q_2) < C(q_1) + C(q_2)$.

divestiture Bell Operating Companies, Western Electric and Bell Telephone Laboratories from AT&T.[4] A part of AT&T's first line of defense was claiming to be a natural monopoly. As seen in the theoretical section above, it would not be an easy task to conclude whether it actually were a natural monopoly. Considered as a whole, the economic debate has been inconclusive.

Fuss[26] presents a few studies from the late 1970s and 1980 trying to estimate the degree of overall scale economies using the translog specification of the cost function. The studies gave estimates evaluated at sample means ranging from 0.94 to 2.12 where an estimate greater than one indicates economies to scale, equal to one constant returns to scale, and less than one diseconomies to scale.

Shin and Ying[59] suggest the inconsistency of earlier results to depend on the level of aggregation of time series data and on the number of observations. When using a small number of highly correlated observations the estimate gets susceptible to specification and estimation techniques. Moreover, the rapid technological progress may bias the estimates upward indicating larger economies of scale than actually being present. Estimating scale economies in an industry with demand growth and rapid technological progress it is important to separate the two effects so that economies of scale are not confused with cost reductions due to the technological progress.

Evans and Heckman[22] proposed a test not requiring global information of a firm's cost function and escaped the problem of extrapolation of the estimated cost function well outside the range of available data. They estimated the multiproduct cost function and then executed a test within an admissible region of outputs, i.e., within the range of available data. The test was simply to examine if there was some product combination within that range that was cheaper to produce separately than jointly. If any such combination is found the industry can not be a natural monopoly because economies of scope is a necessary condition. They carried out the test on the Bell System and were able to reject the hypothesis of subadditivity at the output levels produced for each year 1958-77 when using data from the actual year. Röller[58] refines Evans and Heckman's model by imposing restrictions derived from economic theory on the parameter space of the flexible functional form. He could not reject subadditivity.

Many studies uses aggregated data which, as mentioned earlier, can be problematic. Shin and Ying[59] uses data from 58 LEC's (Local Exchange Carriers)

[4]The Bell Operating Companies were 22 local telephone companies.

to test the hypothesis of LEC's being natural monopolies.[5] The hypothesis is rejected remoting the possibility of AT&T being a natural monopoly since the LEC's were an integral part of the BOC's (Bell Operating Companies).

3. Public Pricing and Regulation

In the previous section we saw that the U.S. government intervened in the telecommunication market. The arguments for governmental intervention can generally be divided into to two major categories: (i) (economic) efficiency and (ii) distributional/political reasons. The efficiency argument is to avoid market failures brought about by competition. Competition only looks to the firm's profit but the consumption of a good, or a service, may create a value to the consumer which is not incorporated in the firm's revenue. This is the so called consumer surplus. Economic efficiency incorporate consumer surplus and requires a good to be produced if consumption generates a value greater than the cost of production. A public enterprise may be created to assure production in a market where the financial deficit is outweighed by consumer surplus making production socially desirable. In the case of a profit maximizing monopoly, the marginal utility of consumption will be greater than the marginal cost of production. The benevolent regulator will then try to achieve economic efficiency by regulating prices etc.

Distributive objectives are by nature normative. But one major and commonly accepted objective is to ensure universal supply of necessary goods, e.g. energy, communication, transportation, and housing.

In the case of the telecommunication industry both classes of arguments have been used to justify various regulations. Price-regulations have been used to offset the disadvantages of monopoly, and regulations specifying responsibilities to achieve universal service and uniform prices. The common telecommunication policy has been to create a private or public monopoly and let long distance calls subsidize local calls and installation fees in order to achieve a high penetration rate. Regulations of price-cap types have slowly started to replace the previously used cost-based types.[6]

[5] LEC is the local network supplier.

[6] Price-cap regulation is to regulate prices and letting the firm decide in any other matter. The price of a good, or the average price of a basket of goods, may not be allowed to increase more than some index, say CPI (Consumer Price Index) - x where x captures productivity growth. For a short introduction of price-cap regulation, see Laffont and Tirole[43] pp. 13-19.

A problem with regulation is that second-best pricing rules[7] will probably be prevented by political restrictions or the authorities' lack of information. Danielsen et al[18] discuss second- and third-best pricing rules, Arnott and Kraus[6] the Ramsey problem for congestible facilities and Konishi et al[38] welfare in an oligopolistic competition model where the government is unable of controlling prices but is able to regulate entry in the oligopolistic sector. A short but useful introduction to the theory of detecting and measuring cross-subsidies is provided by Curien[17].

3.1. The United States

On January 1 1984 AT&T was divested of its operating companies but was allowed to retain Western Electric and Bell Telephone Laboratories contrary to the government's original petition. It was commonly believed that AT&T in fact won by losing the court battle. Operating in the long distance market and in possession of its high-tech equipment AT&T would benefit from increased competition while the BOC's, now organized in 7 regional holding companies (RBOCs or "Baby Bells"), would be worse off. The opposite is, however, suggested by the early evidence.[8] In the beginning the major event seemed to be divestiture rather than deregulation. Intra- and interstate telephone services continued to be subject to formal regulation.[9] The divestiture led to adoption of FCC's Access charge plan.[10] Telephone subscribers pay a flat rate fee (Subscriber Line Charges) while usage-based charges was imposed on interchange carriers (Carrier Common Line and Traffic Sensitive rates). The long-distance to local subsidization was slowly rebalanced by increasing subscriber line charges making final consumers pay a larger share of local fixed costs. Taylor and Taylor[64] show that the regulation of competition in the interstate market has not led to an expansion of demand, i.e., toll demand did not grow more than would be expected from changes in prices, population and consumer income. Furthermore, the overall reduction in long-distance prices was larger than explained by the reduction of carrier access

[7] In some situations it is impossible to reach the economically efficient allocation. There may be financial or political constraints. Losely speaking, optimization subject to constraints yields a second best solution because it would be "first best" to optimize without any constraints at all.

[8] See, for example, Shin and Ying[60], Crandall[16], and Ross and Scheerer[57] page 464.

[9] Crandall [16].

[10] Federal Communications Commission.

charges. In 1989 the FCC adopted price-cap regulation. Three baskets of services was created and each basket were designed to discourage cross-subsidization between baskets while permitting price flexibility. Basket 1 includes residential and small business services, basket 2 inbound 800-services,[11] and basket 3 other price cap services such as private line networks, data transmission services etc. used by businesses. The average price of each basket was not allowed to change annually by more than inflation minus an additional productivity factor of 3 percent. As a service becomes sufficiently competitive it may be removed from the basket. By 1993 regulations were removed for most services in basket 3 and the removal of some services in basket 2 was scheduled.[12]

Noam[51] makes the following conclusions of the effects of divestiture and deregulation: (i) The benefits of monopoly seem only to have been lost in the privacy and reliability areas. The connection of many different local and interstate networks made them more open and increased exchange of information about user and use. The system seem also to have suffered when it comes to robustness to shocks. (ii) Telephone penetration rate did not decline,[13] prices for local telephone service increased by 56.2% while 300% were predicted, and interstate toll fell by 33%. Productivity growth seemed almost unaffected and R&D has increased.

Competition in interstate traffic has increased and even though almost all registered competitors are resellers of network capacity there are four competing networks instead of one. AT&T's share of interstate switched-services long distance usage fell from 84% in 1984 to 63% at the end of 1993.[14] On the local market competition emerges slowly and alternatives are almost always reserved for larger users. Competition in the switching and transmission equipment market has increased sharply.

[11] This service allows, as an example, a customer to place a toll free call to a business establishment which is billed for the call. The same number can be used in a number of different areas to make if more visible to it's customers.

[12] Braeutigam and Panzar [12].

[13] This conclusion is also supported by Hausman et al[33]. The price elasticity for subscription in the U.S. is highly inelastic (Source: Appendix in Bodnar[11]).

[14] Taylor and Taylor[64].

3.2. Sweden

The Swedish government's objective with various regulations is to guarantee universal service, regional balance, etc. at lowest possible loss of welfare.[15] Televerket, the former public enterprise, has never had its monopoly protected by law but never the less enjoyed a *de facto* monopoly. During the 1980s competition gradually emerged and regulations were removed. Permanent residence subscription charges, metre unit charges, and the metre unit length for local calls was set by the government. In other areas could Televerket set prices freely, but major price changes must be authorized by the government. An additional requirement affecting pricing is a minimal requirement on real return of equity.[16] Today, the basis of the Swedish telecommunication policy is to increase efficiency by introducing competition. Entry will be facilitated in toll-, business-, data communication-, and mobile telephone markets. Competition is supervised by Konkurrensverket (the competition agency) and a new authority, Post- och Telestyrelsen (National Post and Telecommunication Agency), handles the tasks of authority earlier assigned to Televerket. On July 1 1993 Televerket was made a joint-stock cooperation and renamed Telia AB.[17]

A study by Pousette[55] (1978) examines the efficiency-aspect of pricing of telecommunication services and investments in telecommunication. It is interesting to see that local and all toll tariffs were higher than both the optimal tariff and average cost.[18] The subscription charge was, however, substantially below its average cost.[19]

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[15]Sources: Statens pris- och konkurrensverk[62] and Bergendorff[9].

[16]Solvency was required to be at least 65% at the end of 1992.

[17]Telia AB is parent company to Telia Mobitel, Telia Megacom, Telia International, Telia Data, Telia Research, Telefinans, Fastighets AB Telaris, and Telia Holdings AB (Source: Teldok [66], pp. 203). In contrast to British Telecom Telia AB was never privatized.

[18]Pousette[55] table 1:1, page 25. In a U.S pre-divestiture era study Griffin[32] found the welfare loss due to price deviation from marginal cost in the long-distance market to be large.

[19]For a discussion of the case of the United Kingdom see Rehn[66], Pydokke[56], and Helm[30]. Blankart and Kneips[10] and Kneips et al[37] treat the case of Germany, and Müller[50] the European common market.

4. Estimating Demand

One major research field in the telecommunication literature is that of estimating the demand for different telecommunication services. Much research has been financed by AT&T. Demand information is essential for a firm when setting prices and planning investments. But it is also vital for the regulator. These facts have contributed to the richness of this literature.

Until the mid 1970s econometric models were little used within the U.S. telecommunication industry.[20] During the 1960s and early 1970s they used a mathematical simulation model, LDI, developed at the AT&T Long Lines to analyze changes in revenue from different interstate toll schedules. In the late '70s LDI was replaced by two econometric models, FIRM and RES. The focus was almost entirely on toll until about 1980. Then, AT&T and others realized that increased competition in the toll-market made the toll-to-local-subsidy impossible to sustain. Prices would have to adjust and be more cost-based making each service carry its own costs to a larger extent. Now, the focus switched to a broad variety of elasticities on the local markets such as shifts in penetration-rates due to increased installation fees and variations with respect to socio-demographic parameters etc. With the divestiture focus shifted again. The divestiture created new markets, such as bypass of local exchange companies, and made demand data, which had previously been public, private propriety. Hence, estimating demand became more difficult overnight.

An analyst estimating telecommunication demand is confronted with a wide range of practical problems, such as multicolinearity, implementation of theory, data limitations etc. Two lines of solutions have been commonly accepted, the first is to work with demand system models and the second is to expand data by pooling time-series and cross sectional data.[21]

Demand systems offer a more accurate modeling of consumer behavior. Different services, e.g. local and toll, can be modeled as different goods. The demand for local telecommunication services can be separated from the demand for toll services. Demand systems can also be made to embody a number of restrictions.[22]

[20] The historical part follows briefly Taylor[63].

[21] Gatto et al [28] pp. 284.

[22] Restrictions can in turn be divided into (i) general and (ii) particular restrictions. General restrictions (such as homogeneity of degree zero and symmetry etc.) are restrictions derived from consumer theory and particular restrictions (such as homothetic preferences etc.) are derived from additive assumptions.

The second solution, pooling of time-series and cross-section data, increases the number of observations thus increasing the degrees of freedom available to estimate various demand elasticities etc. Pooling also mitigates multicolinearity between price and explanatory income variables. Moreover, it makes the model suffer less from the potential of aggregation bias than aggregate demand models do.[23]

Egan and Griffin[21] postulate that a multi-block tariff good may be thought of as multiple goods. Telecommunication services have different rate periods and pricing schedules may depend on type of subscription. They use a system of demand equations to estimate "aggregate" demand taking the substitution among these "goods" into account. For more on multiple goods, see Ben-Akiva et al[8] and Kridel[40] [41].

Gatto et al[28] combine both approaches, pooling and demand systems, by using a model in which interstate toll demand is disaggregated by mileage bands, time-of-day, and non-operator/operator-handled. However, a paradox with demand equation systems is that they regularly reject the restrictions in applied studies. Gatto et al[28] therefore replaced the deterministic restrictions with their weaker stochastic counterparts. The benefit is twofold. First, the number of parameters to be estimated decreases substantially and, second, stochastic restrictions allow for individual differences in the decision units. Furthermore, the restrictions are made weaker and are therefore more likely to be consistent with the data set. The paper is theoretically interesting but has a drawback when it comes to discussing the empirical results. Due to the proprietary nature of used data the authors provide elasticity coefficients for only one anonymous milage band and ten anonymous cross-sections.[24]

FCC used in 1986 an econometric model to forecast interstate switched access demand in order to find a justifiable Carrier Common Line charge rate. Gatto et al[28] describes an extended version of this model used by AT&T in 1988. It is a polynomial distributed lag model working with state-level pooled cross-sectional time-series. They estimated the long run price elasticity to be -0.72 and the short run to be -0.46. Estimates are highly significant and well in line with the estimates of other studies. Estimated income- and population elasticities were 0.83 and 1.21, respectively.

Appelbe et al[5] use pooled time-series cross-section data modeling point-to-

[23] Gatto et al[29], pp. 338-339.

[24] Totally there were 5 milage bands and 49 cross sectorial units.

point traffic flows between companies and regions in Canada and between Canada and the U.S. The rich point-to-point framework allows for estimation of a wide variety of price elasticities. One major finding concerns the reciprocal calling coefficient which is the responsiveness of calling from company A to B due to a change in calling from B to A. The reciprocal calling coefficient ranges around 0.5 indicating "the calling-back effect" to be important. If company B were to lower its charges the numbers of calls made from B would increase. But so would also the number of calls received. For two extra calls made, one call would be received thus increasing the revenue.

Bodnar et al[11] analyses residential telephone subscription in Canada by using cross-sectional data. They conclude the demand to be highly inelastic with respect to own price, -0.009. The impact of other explanatory variables such as age and household income are also analyzed. Their result suggests the Canadian demand to be more inelastic than its U.S. counterpart which has been estimated to range from -0.037 to -0.087.[25]

Traditionally, telecommunication demand analysis has taken "habit" formation into account through the use of lag structures. The length of the lag is often set to about four quarters. Breslaw and Pizante[13] suggest the adjustment process to be considerably longer after having studied data from Bell Canada. Half the long run effect was achieved after five quarters and 75 percent in 9 quarters. They also find consumers to greatly overstate toll rates.[26] Between 18 and 29 percent of the respondents believed long distance rates to be more expensive than the year before, even though a 20 percent price cut were heavily used in an advertising campaign by Bell Canada.

Acton and Vogelsang[1] analyses international demand for telecommunication between the U.S. and 17 West European countries. The own-price elasticity (demand change due to price changes in the originating country) is negative in both directions and the cross-price elasticity is insignificant.

4.1. The Case of Sweden

The objective of an early study by Pousette[54] (1976) was to make telecommunication- and telephone demand forecasts for Sweden 1975-1980 using data ranging

[25]The appendix in Bodnar et al[11] contains a summary of U.S. binary choice access demand studies.

[26]In average, toll rates were overstated by 100 percent.

from 1949 to 1974. Demand was divided into intra- and international demand by households, industry, and public administration. One merit of the study is the exhaustive description of Swedish telecommunication development during the 25 year period 1949-1974. Sjöholm[61] estimated the price elasticity of telecommunication to be as high as -0.9 and the expenditure elasticity to be 1.08.[27] Furthermore, he finds postal and telecommunication services to only be weak substitutes. Taymaz[65] performs in a recent study a micro-simulation analysis of manufacturing firm's demand for telecommunication services.[28] The results are inconclusive heightening the need for further research.

5. Deterring Entry

The telecommunication industry is highly regulated. It is well known that regulation can induce supranormal profits in the whole industry or in segments of it. The most common kinds of regulations have been regulation of entry, quality, and prices. An example of the former is the market for switching and transmission components.[29] The latter can be exemplified by the toll market where regulated prices well above marginal- and average cost have subsidized the local calls and made entry attractive. Conversely, there have been few entries in the local market. Regulation of quality is, as an example, requirement of universal service.

Supranormal profit induces incentives to enter but it also induces the incumbent to deter or limit entry. The incumbent (regulatee) may block entry by influencing the regulator, so called regulatory capture. The regulatee usually has an information advantage over the regulator. This advantage may be used to deter, limit, or delay entry. Even though the regulatee is likely to try to capture the regulator, I will pay this aspect no further attention and instead concentrate on methods used in the absence of regulations.[30] Various regulations may then be viewed as restrictions imposed on the incumbents (long run) profit maximization problem.

[27] Telecommunication is broadly defined and incorporates all kind of telecommunication, e.g. subscription and the fixed part of the tariff as well as the usage sensitive. Data is from the period 1932-1991.

[28] Taymaz study has much in common with Antonelli[3] who studies the Italian manufacturing industry's demand for telecommunication services.

[29] See Müller[50] and Crandall[16].

[30] For the theory of regulatory capture, see Laffont and Tirole[43] ch. 11. Helm[30] discusses, among other things, information monopoly and regulatory capture in Great Britain.

In the market for telecommunication services competition is mainly through prices. It is not possible to produce a certain quantity and bring it to the market where it is sold at some equilibrium price. Instead, the producer supplies the service upon the consumer's request. Demand is, in turn, determined by prices etc. Of course, one may suggest that competition is in capacity, but the marginal cost of capacity ought to be fairly low when investing in a new network. We seldom observe telecommunication networks in which demand regularly exceeds supply, i.e. the capacity limit. Hence, I will concentrate on competition in prices.

The key to entry deterrence is the incumbent's ability to create credible "threats" of making an entrant's profit sufficiently low. In the literature of industrial organization there are two main lines of thought being of relevance in the case of perfect information: Economies of scale (e.g. fixed costs) and sunk costs. Signaling through prices is the key element to deter entry when information is asymmetric.[31]

5.1. Sunk and Fixed Costs

In the following I will consider the standard case of one incumbent, one potential entrant, and one homogeneous good. Recall the intuitive interpretation of natural monopoly from section 1. An industry is said to be a natural monopoly if no more than one firm can make non-negative profits in that market. I also briefly mentioned the connection between fixed costs and natural monopoly. Economies of scale due to large fixed costs or barriers to entry makes the minimum efficient production of each firm a significant proportion of the market and thereby, the argument goes, limits the number of firms making positive profits while operating in the market. Our incumbent can therefore enjoy supranormal profits without worrying if it is well known that duopoly profits will be negative.

Against this argument one objection has been raised. It is the so called war of attrition in which the entrant enters and both firms make negative profits until one of them leaves the market.[32] Future profits encourages entry and thereby, at least in the short run, competition.

The incumbent may be able to commit to stay in the market long enough to make entry unprofitable. By staying in the market he lowers the entrant's profit

[31] The sections discussing perfect information follows briefly chapter 8 in Tirole[67] and the sections concerning asymmetric information chapter 9.

[32] See Mankiw and Whinston[46] and Ghemawat and Nalebuff[31].

of today and makes future gains more distant. He thereby lowers the net present value of entering and thus the incentive to enter. The obvious question begging for an answer is: How can a firm commit to stay in a market in which profits are negative or not to accommodate entry even though it would increase own profits? The answer can, at least partly, be found in the distinction between fixed and sunk costs.

One may think of a sunk cost as a firm-specific investment with no intrinsic value and that can not be allocated into another use within the firm. Such an investment has no value on a second-hand market. A fixed cost is a cost independent of scale of production. Generally, it is sunk for some (short) period of time, e.g. it may take a month or a year to find a buyer to the facility in question and to settle the bargaining. For that period it is costless to stay in the market in the sense that the made investment has no alternative value. Hence, the only costs that must be covered are variable costs. The market price will be above marginal cost and the threat of staying in the market for some time-period will be credible if we assume firms to have access to the same technology. With credible I mean that it is rational to stay in the market, i.e. it maximizes profit. A (pre-entry) sunk cost changes the post-entry incentives of the incumbent making the threat of non-accommodation credible.[33]

5.2. Limit Pricing and Predatory Pricing

The entrant has often incomplete information concerning the incumbent's cost function. In the simplest case there are two types of incumbents, one high-cost type and one low-cost type. The entrant observes the incumbents pricing behavior before deciding whether to enter or not. If he observes a low price this is bad news about future profits and he chooses to stay out. Whether the incumbent engages in limit pricing, i.e. sets a price lower than his monopoly price, will depend on (i) the differences in costs between the high cost type, the low cost type, and the entrant and (ii) the entrant's prior belief of which type the incumbent is.

[33]How an incumbent acts does not only depend on how flexible prices are or the length of period a fixed cost is sunk. It also depends on the good sold. Deterring entry almost always requires overinvestments, but this is not always the case when accommodating entry. It will depend on whether investments lowers the marginal cost of production or not. Investments may, if they lowers the marginal cost, trigger a price-war which hurts the incumbent. Readers interested in investment strategies is recommended Tirole[67] pp.326-328 for an introduction and further references.

The same argument applies to a situation where there are two firms in the market. Now, a low price signals low costs and is intended to drive the other firm out. This behavior is called predatory pricing.[34]

5.3. The Chain-store Paradox

In section 3 we saw that a multi-block tariff good, such as telecommunication services, may be viewed as multiple goods. During the pre-deregulation era production of almost all goods was gathered together into one heavily regulated enterprise. Deregulation has then opened up some of these "sub-markets" for competition. It is important to realize that the incentive to deter entry in one market is stronger for a multimarket incumbent than for a single-market incumbent when information is incomplete. The former has also his reputation to take into account. The way he acts in one market will be observed by potential entrants in other markets. Low prices in one market may signal low costs in another market. A multimarket incumbent acting weakly and accommodates in one market is likely to encourage entry in another market, and vice versa. Hence, accommodating is more costly to a multimarket incumbent and we may observe him deter entry in markets where his single-market counterpart would have accommodated. This result is the well known Chain-store paradox.[35]

6. Summary and Comments

The literature discusses mainly three topics. The first is the question of the telecommunication industry being a natural monopoly. We have touched on the theoretical foundations and found the empirical literature to be inconclusive. The rapid technological progress and the nature of data makes investigation difficult. The second topic is regulation and the effects of deregulation. The telecommunication industry has, as a rule, been heavily regulated since the beginning of the century. Effects of the last decades deregulation has, on the whole, been positive. The third topic is estimation of demand for various telecommunication services. Two different approaches, pooling of data and demand systems, to mitigate practical problems such as multicolinearity etc. has been discussed.

[34]For an introduction to the literature of limit pricing and predatory pricing, see Cho and Kreps[15], Kreps and Wilson[39], LeBlanc[44], and Milgrom and Roberts[47] [48].

[35]Tirole[67], pp. 376-377.

Demand for telecommunication services as well as subscription are almost always found to be inelastic. However, deregulation has made data proprietary and made econometric work much more difficult.

The last part of the survey sketches some main findings in the field of industrial organization concerning means of deterring entry or making entry less attractive. Sunk costs play a central role in deterring entry when information is perfect because it changes the incumbents post-entry incentives making it rational to not accommodate. In the case of incomplete information prices are used to signal that the incumbents costs are low and that entry will trigger throat cut competition.

I have chosen not to discuss network externalities and standardization. Readers that are interested in these topics are recommended Farrell and Saloner[24], Katz and Shapiro[36], Liebowitz and Margolis[45], and Kandori et al[35]. The Teldok-series are recommended to those readers who are interested in telecommunication in general. These publications are available in Swedish and some also in English. OECD has the ICCP-series (Information Computer Communication Policy) all available in English. An economic perspective is found in the journal Information Economics and Policy.

Last, some readers may have noticed that no literature concerning the mobile telephone market have been accounted for. The absence of such literature is striking, especially when the market experiences a phase of rapid demand growth and technological progress which heightens the need of research.[36] Perhaps this is the next field of literature on telecommunications.

[36]There is some literature in business economics and a few unpublished working papers.

References

[1] **Acton, Jan Paul and Ingo Vogelsang,** *Telephone Demand over the Atlantic: Evidence from Country-Pair Data*, The Journal of Industrial Economics, Vol. XL (1992), no. 3, pp. 305-323

[2] **Antonelli, Cristiano**, *Externalities and Complementaries in Telecommunications Dynamics*, International Journal of Industrial Organization, Vol. 11 (1993), pp. 437-447

[3] **Antonelli, Cristiano**, *Information Technology and the Derived Demand for Telecommunication Services in the Manufacturing Industry*, Information Economics and Policy, Vol. 4 (1989/90), pp. 45-55

[4] **Anselmo, Peter C. and Toshiyuki Sueyoshi,** *The Evans and Heckman Subadditivity Test: Comment*, The American Economic Review, Vol. 76 (1986), pp. 854-855

[5] **Appelbe, T. W., N. A. Snihur, C. Dineen, D. Farnes, and R. Giordano,** *Point-to-Point Modelling, An Application to Canada-Canada and Canada-United States Long Distance Calling*, Information Economics and Policy, Vol. 3 (1988), pp. 311-331

[6] **Arnott, Richard and Marvin Kraus,** *The Ramsey Problem for Congestible Facilities*, Journal of Public Economics, Vol. 50 (1993), pp. 371-396

[7] **Bagwell, Kyle and Garey Ramey**, *Oligopoly Limit Pricing*, Rand Journal of Economics, Vol. 22 (1991), pp. 155-172.

[8] **Ben-Akiva, Moshe, Daniel L. McFadden, and Kenneth E. Train,** *The Demand for Local Telephone Service: A Fully Discrete Model of Residential Calling Patterns and Service Choices*, Rand Journal of Economics, Vol. 18, No. 1 (1987), pp. 109-123

[9] **Bergendorff, Hans**, *Vad betyder ökad konkurrens för prissättning av teletjänster?*, Ekonomisk Debatt, no. 6 1990, pp. 587-592

[10] **Blankart, Charles B. and Günter Kneips,** *What Can We Learn From Comparative Institutional Analysis? The Case of Telecommunications*, Kyklos Vol. 42 no.4 (1989), pp. 579-598

[11] **Bodnar, Judith, Peter Dilworth, and Salvatore Iacono,** *Cross-Sectional Analysis of Residential Telephone Subscription in Canada*, Information Economics and Policy, Vol. 3 (1988), pp. 359-378

[12] **Braeutigam, Ronald R. and John C. Panzar,** *Effects of the Change from Rate-of-Return to Price-Cap Regulation*, American Economic Review, Vol. 83 no.2 (May 1993), pp. 191-198

[13] **Breslaw, Jon and Gary Pizante,** *Lag Structure in Telecommunications Demand Analysis*, Information Economics and Policy, Vol. 4 (1989/90), pp. 325-345

[14] **Bös, Dieter**, *Public Sector Pricing*, in Handbook of Public Economics, Vol. 1, edited by A. J. Auerbach and M. Feldstein, 1985, Amsterdam: North-Holland

[15] **Cho, In-Koo and David M. Kreps**, *Signaling Games and Stable Equilibria*, The Quarterly Journal of Economics, Vol. CII (May 1987), pp. 179-221

[16] **Crandall, Robert W.**, *Surprises from Telephone Deregulation and the AT&T Divestiture*, American Economic Review, Vol. 78 (1988) pp. 323-327

[17] **Curien, Nicolas**, *The Theory and Measure of Cross-Subsidies. An Application to the Telecommunication Industry*, International Journal of Industrial Organization, Vol. 9 (1991), pp. 73-108

[18] **Danielsen, Albert L., David R. Kamerschen, and Donald C. Keenan,** *Third-Best Pricing Rules for Regulated Utilities*, Southern Journal of Economics, Vol. 56 (1990), No. 3, pp. 628-638

[19] **Demange, Gabrielle and Dominique Henriet,** *Sustainable Oligopolies*, Journal of Economic Theory, Vol. 54 (1991), pp. 417-428.

[20] **Dilworth, Peter A., Edgardo R. Sepulveda, Shafi A. Shaik, and Genio A. Staranczak,** *Industry Structure, Productivity and International*

Competitiveness: The Case of Telecommunications, Information Economics and Policy, Vol. 6 (1994), pp. 121-142

[21] **Egan, Bruce L. and James M. Griffin,** *Demand System Estimation in the Presence of Multi-Block Tariffs: A Telecommunications Example*, The Review of Economics and Statistics, Vol. LXVII (1985), pp. 520-524

[22] **Evans, David S. and James J. Heckman,** *A Test for Subadditivity of the Cost Function with an Application to the Bell System*, The American Economic Review, Vol. 74 (1984), pp. 615-623

[23] **Evans, David S. and James J. Heckman,** *Erratum: A Test for Subadditivity of the Cost Function with an Application to the Bell System*, The American Economic Review, Vol. 76 (1986), pp. 856-858

[24] **Farrell, Joseph and Garth Saloner**, *Standardization, Compatibility and Innovation*, RAND Journal of Economics, Vol. 16 (1985), no. 1, pp.70-83.

[25] **Farrell, Joseph and Carl Shapiro,** *Dynamic competition with Switching Costs*, Rand Journal of Economics, Vol. 19 (1988), pp. 123-137.

[26] **Fuss, M. A.**, *A survey of recent results in the analysis of production conditions in telecommunications*, In L. Courville, A. de Fontenay and R. Dobell, eds., Economic Analysis of Telecommunications: Theory and Applications, Amsterdam: North-Holland (1983)

[27] **Fölster, Stefan**, *The Information Sector in Sweden*, In Gunnar Eliasson et al, The Knowledge Based Economy, The Industrial Institute for Economic and Social Research, Almqvist&Wicksell International 1993

[28] **Gatto, Joseph P., Harry H. Kelejian, and Scott W. Stephan,** *Stochastic Generalizations of Demand Systems with an Application to Telecommunications*, Information Economics and Policy, Vol. 3 (1988), pp. 283-309

[29] **Gatto, Joseph P., Jerry Langin-Hooper, Paul B Robinson, and Holly Tyan,** *Interstate Switched Access Demand Analysis*, Information Economics and Policy, Vol. 3 (1988), pp. 333-358

[30] **Helm, Dieter**, *British Utility Regulation: Theory, Practice, and Reform*, Oxford Review of Economic Policy, Vol. 10 (1994), No. 3, pp. 17-39

[31] **Ghemawat, P and B. Nalebuff**, *Exit*, Rand Journal of Economics, Vol. 16 (1985), pp. 184-194.

[32] **Griffin, James M.**, *The Welfare Implications of Externalities and Price Elasticities for Telecommunication Pricing*, The Review of Economics and Statistics, Vol. LXIV (1982), pp. 59-66

[33] **Hausman, Jerry, Timothy Tardiff, and Alexander Belinfante**, *The Effects of the Breakup of AT&T on Telephone Penetration in the United States*, American Economic Review, Vol. 83 no.2 (1993), pp. 178-184

[34] **Johnson, Leland L.**, *Dealing with Monopoly in International Telephone Service: A US. Perspective*, Information Economics and Policy, Vol. 4 (1989/91), pp. 225-247

[35] **Kandori, M., G. Mailath, and R. Rob**, *Learning, Mutation, and Long Run Equilibria in Games*, Econometrica, Vol. 61 (1993), pp. 29-56

[36] **Katz, Michael L. and Carl Shapiro**, *Network Externalities, Competition, and Compatibility*, American Economic Review, Vol. 75 (1985), no. 3, pp. 424-440

[37] **Kneips, Günter, Jürgen Müller, and Carl Christian von Weizsäcker**, *Telecommunications Policy in West Germany and Challenges from Technical and Market Development*, Journal of Economics 1982 (Suppl. 2), pp. 205-222

[38] **Konishi, Hideki, Masahiro Okuno-Fujiwara, and Kotoro Suzumura**, *Oligopolistic Competition and Economic Welfare. A General Equilibrium Analysis of Entry Regulation and Tax-Subsidy Schemes*, Journal of Public Economics, Vol. 42 (1992), pp. 67-88

[39] **Kreps, David M and Robert Wilson**, *Reputation and Imperfect Information*, Journal of Economic Theory, Vol. 27 (1982), pp. 253-279.

[40] **Kridel, Donald J.**, *A Consumer Surplus Approach to Predicting Extended Area Service (EAS) Development and Stimulation Rates*, Information Economics and Policy, Vol. 3 (1988), pp. 379-390

[41] **Kridel, Donald J., Dale E. Lehman, and Dennis L. Weisman,** *Option Value, telecommunications Demand, and Policy*, Information Economics and Policy, Vol. 5 (1993), pp. 125-144

[42] **Laber, Gene**, *What Can We Learn From Comparative Institutional Analysis? The Case of Telecommunications: A Note*, Kyklos, Vol. 44 no.3 (1991), pp. 431-437

[43] **Laffont, Jean-Jacques and Jean Tirole,** A Theory of Incentives in Procurement and Regulation, MIT-Press, 1993

[44] **LeBlanc, Greg**, *Signalling Strength: Limit Pricing and Predatory Pricing*, Rand Journal of Economics, Vol. 23 (1992), pp. 493-506.

[45] **Liebowitz, S. J. and Stephen E. Margolis**, *Network Externality: An Uncommon Tragedy*, Journal of Economic Perspectives, Vol. 8 (1994), no. 2, pp. 133-150

[46] **Mankiw, G and M. Whinston**, *Free Entry and Social Inefficiency*, Rand Journal of Economics, Vol. 17 (1986), pp. 48-58.

[47] **Milgrom, Paul and John Roberts,** *Limit Pricing and Entry under Incomplete Information: An Equilibrium Analysis*, Econometrica, Vol. 50 (1982), pp. 443-459.

[48] **Milgrom, Paul and John Roberts,** *Predation, Reputation, and Entry Deterrence,* Journal of Economic Theory, Vol. 27 (1982), pp. 280-312.

[49] **Mookherjee, Dilip and Debraj Ray,** *Collusive Market Structure Under Learning-By-Doing and Increasing Returns,* Review of Economic Studies, Vol. 58 (1991), pp. 993-1009.

[50] **Müller, Jürgen**, *The European Internal Market for Telecommunications*, European Economic Review, Vol. 35 (1991), pp. 496-503

[51] **Noam, Eli M.**, *Assessing the Impacts of Divestiture and Deregulation in Telecommunications*, Southern Journal of Economics, Vol. 59 (1993), No. 3, pp.238-249

[52] **Palmer, Karen**, *A Test for Cross Subsidies in Local Telephone Rates: Do Business Customers Subsidize Residential Customers?*, Rand Journal of Economics, Vol. 23 (1992), pp. 415-431

[53] **Panzar, J. C.**, *Determinants of Firm and Industry Structure*, In Handbook of Industrial Economics, Ed. Richard Schmalensee and Robert D Willig, 1989, Amsterdam: North-Holland

[54] **Pousette, Tomas**, *Efterfrågan på telefontjänster och telefoner. En ekonometrisk studie*, Forskningsrapport no. 6, 1976, Industriens Utredningsinstitut

[55] **Pousette, Tomas**, *Teletjänster - priser och investeringar. En samhällsekonomisk studie*, Industriens Utredningsinstitut, Almqvist&Wicksell International, 1978

[56] **Pyddoke, Roger**, *Politik för ett naturligt monopol - fallet Televerket*, In Sveriges systemskifte i fara? Erfarenheter av privatisering, avreglering och decentralisering by Stefan Fölster et al, Industriens Utredningsinstitut, Almqvist&Wicksell International, 1993

[57] **Ross, David and F. M. Scherer,** *Industrial Market Structure and Economic Performance*, Houghton Mifflin Company 1990, 3rd edition

[58] **Röller, Lars-Hendrik**, *Proper Quadratic Cost Function with an Application to the Bell System*, Review of Economics and Statistics, Vol. 72 (1990), pp. 202-210

[59] **Shin, Richard T. and John S. Ying,** *Unnatural Monopolies in Local Telephone*, Rand Journal of Economics, Vol. 23 (1993), pp. 171-183

[60] **Shin, Richard T. and John S. Ying,** *Costly Gains to Breaking up: LECS and the Baby Bells*, The Review of Economics and Statistics, Vol. LXXV (1993), No. 2, pp. 357-361

[61] **Sjöholm, Kent Rune**, *Hierarchical Modelling of Private Demand in Sweden*, The Industrial Institute for Economic and Social Research, Almqvist&Wicksell International 1993

[62] **Statens pris- och konkurrensverk**, *Prissättning på monopolmarknader. En studie av postverket och televerket*, SPKs Bokserie 1989:3, Allmänna Förlaget

[63] **Taylor, Lester D.**, *Telecommunications Demand Modeling. The Current State-of-the-Art*, Information Economics and Policy, Vol. 3 (1988), pp. 277-281

[64] **Taylor, William E. and Lester D. Taylor,** *Postdivestiture Long-Distance Competition in the United States*, American Economic Review, Vol. 83 no.2 (1993), pp. 185-190

[65] **Taymaz, Erol**, *A Micro-Simulation Analysis of Manufacturing Firm's Demand for Telecommunication Services*, In Gunnar Eliasson et al, The Knowledge Based Economy, The Industrial Institute for Economic and Social Research, Almqvist&Wicksell International 1993

[66] **Teldok**, *Teldok's Årsbok 1994*,

[67] **Tirole, Jean**, *The Theory of Industrial Organization*, MIT Press 1990 (1988), chapter 1, 8, and 9

[68] **Wolak, Frank A.**, *Telecommunications Demand Modeling*, Information Economics and Policy, Vol. 5 (1993), pp. 179-195