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DEREGULATION OF NETWORK INDUSTRIES AN ANALYSIS OF DUTCH TELECOMMUNICATIONS

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ABSTRACT

Deregulation has become common practice in many utility sectors. However, entry will not always improve welfare. Regulation remains necessary, if industries feature large economies of scale. Technological progress can create competition between infra-structural networks The paper points out that the introduction of a new infrastructure could be arrested by vertical integration of incumbents. Entry into mobile telephony is limited due to scarcity of spectrum frequencies. Auctions can be used to transfer scarcity rents to governments. An analysis of five European spectrum auctions conducted in 2000 shows that auction outcomes are largely determined by initial market structures.

Key words: limit price, vertical integration, Stackelberg and Cournot equilibrium, UMTS auctions

Deregulation of Network Industries: An Analysis of Dutch Tele-communications

1. INTRODUCTION

Welfare economics generally concludes that market performance is optimal, if perfect competition prevails. However, most industries are characterized by cost structures that differ from perfect competition. This applies particularly to capital intensive industries possessing vast economies of scale. Utilities such as gas, water, electricity, railways and telecommunications are cases in point. These industries are subject to large economies of scale due to investments in networks and were considered natural monopolies. State-ownership and/or regulation were devices used to prevent private exploitation of monopoly power. Government intervention was also prompted to stimulate universal access to utilities, such as telephone or railway transport services. As a consequence, telephone connections were often installed at uniform prices, whereas costs differ considerably between connecting somebody in a metropolitan area or in a remote mountainous region. Government ownership of utilities was much more common in Europe than in the US. Many European telecommunication companies were state-owned (the national PTT's) and regulated by a state department. Regulatory authorities set US prices of public utilities.

Government regulation also involves non-utility industries. The regulation of prices of agricultural products constitutes a prominent example. Other examples of regulation can be found in the limits imposed on entry in many professional services such as lawyers, physicians and notaries. People can only start in these professions, if they got a license. The rules for licensing are usually set by professional organizations such as the bar associations in the case of lawyers. Self-regulation tends to restrict entry and to rise prices. (Artificial) scarcity creates rents and transfers wealth from consumers to firms. These wealth transfers can be considerable as is illustrated by the price of taxi licenses in New York City which amounted to 180.000 $ in 1993.

This paper focuses on issues of regulation and deregulation in network industries such as telecommunications and the cable sector. Economies of scale and universal access constituted the main arguments for government interference in these industries. Regulation of a natural monopoly can be economically sound. Welfare is improved, if

regulation lowers prices and expands output. However, regulation also causes costs that may exceed the welfare gains of regulation. Regulatory bodies are inclined to expand their personnel. Personnel in the US regulatory agencies increased from 70.000 in 1970 to 128.000 in 1999 in spite of deregulation (Carlton et al. 650). Moreover, regulation can lead to other market failures, such as overcapitalization. Another drawback of regulation involves the lack of incentives to increase efficiency and stimulate innovation.

The alleged inefficiencies of regulation inspired a wave of deregulation in the 1980s that was led by the Reagan administration in the US and the Thatcher government in the UK. Deregulation was prompted by new theoretical insights and by technological developments. Contestable market theory emphasized free entry instead of regulation as a device to improve industry performance. Technological developments brought less capital-intensive techniques such as mobile telephony to the fore. Several network industries such as telecommunications, airlines, railroads and electricity were opened up for entry. Former monopolists could now be challenged by entrants, but could also pursue strategies of internationalization and vertical integration.

The paper will first address the issue of regulatory pricing in industries featuring natural monopoly. The question is subsequently raised whether network industries are sufficiently competitive, if they are opened for entry or need (re) regulation. Dutch experiences in privatizing and deregulating telecommunications and cables are analyzed from an industrial organization perspective. The paper addresses the issue of possible abuse of market power by vertically integrated cable and telephone companies. The paper then focuses on the allocation of scarce frequencies in mobile telephony. The organization and results of UMTS auctions in the UK, the Netherlands, Germany, Italy and Austria are discussed.

2. HOW TO REGULATE A NATURAL MONOPOLY?

A natural monopoly is usually defined as an industry, in which one firm can produce a market quantity of output at lower costs than two or more firms can. Monopoly spurs efficiency in those industries, but also causes welfare losses due to market power, because monopolies can set price above competitive levels. Most industries are characterized by economies of scale that are exhausted at relatively low output levels.

An industry does not classify as a natural monopoly, if optimal capacity size is smaller than monopoly output. But, utility industries that operate networks with optimal scales ranging from monopoly till perfectly competitive output fit our definition of a natural monopoly. Those utility industries supply homogenous goods and have invested in infrastructures that often reach each and every home and business firm. Electric power companies have invested in wiring grids and telecommunication companies in copper and fiber optic cables. It would be wasteful to duplicate those investments as long as capacity is sufficiently large to satisfy consumer demand at prices that are considered socially optimal. Regulation of a natural monopoly can take several forms as will be illustrated by a simple model. The following linear cost and demand functions are assumed:

$C(Q) = F + cQ$

$P = a - bQ$

A private monopolist would charge the monopoly price (P_m) and supply monopoly output (Q_m). A perfectly competitive firm- in contrast- would charge a price P*, that equals marginal cost c. A monopolist will supply exactly half the amount of a perfectly competitive supplier under conditions of constant marginal costs[1]. However, a supplier would lose an amount equal to annual fixed cost F, if price were set at the level of marginal cost. Governments that want to mimic a perfectly competitive market can achieve this goal by subsidizing the regulated industry by an amount equal to F. One approach to regulation therefore, consists of subsidizing utilities, which usually coincides with government ownership. Government owned railroad companies that are subsidized to achieve optimal utilization of railway tracks are cases in point. Average cost pricing constitutes another approach to regulation. No subsidies are required under such a regulatory regime. Average costs include both variable and fixed (sunk) cost. Each firm of efficient size is assumed to supply a quantity q and to incur fixed cost F. It follows that average costs equals price, if the following identities apply:

$P = ac = c + F/q.$

[1] If the equation for the inverse demand function is $P = a - bQ$, marginal revenue for a monopolist is $a - 2bQm$. Marginal revenue is set equal to marginal cost, which is c. $Qm = \frac{a-c}{2b}$, which is exactly half of perfectly competitive output: $Qc = \frac{a-c}{b}$. Qc is often called S.

Monopoly output Qm = $\frac{a-c}{2b}$ and monopoly price Pm = c + $\frac{a-c}{2}$. Monopoly price will exceed average costs, if fixed (sunk) costs are of a magnitude smaller than monopoly profits [F < (a-c)^2/4b]. Or, to put it differently; excess profits will be earned, if P > c + $\sqrt{bF}$. This identity can be derived applying the rules for profit maximization[2]. Arguably, a natural monopoly only needs to be regulated, if monopoly profits exceed fixed costs. Such a natural monopoly can be represented graphically by an average cost curve, which is continuously declining up to the capacity limit (figure 1). Fixed costs are less than monopoly profits in our example, so that long run competitive price (Pa) is located below monopoly price (Pm).

Figure 1. Price Regulation of a Natural Monopoly

A regulator can set price at the level of average costs P_a. The monopolist then sells Q_a units. This is a second best solution, because price should equal P* to achieve efficient allocation. The perfectly competitive output Q_c or S would then be supplied. However, subsidization can also incur inefficiencies so that average cost pricing may be preferred. A combination of marginal and average cost pricing exists, if utilities charge a two-part

[2] No excess profits are earned, if Πm = F; Πm = (Pm – c) Qm = bQ^{2}m; Qm = $\sqrt{\frac{F}{b}}$.
Pm = c + (a-c)/2; Pm = c + bQm: Pm = c + $\sqrt{bF}$.

tariff, consisting of a fixed fee to cover capital costs and a usage charge to cover variable costs. Price discrimination can also contribute to welfare. Electricity firms charge higher tariffs during the day than the evening (peak load pricing). The rationale for this price differential is that reservation prices for electricity are higher during the day than the night. That is also why telephone tariffs differ for night and day usage and why railroads charge a lower tariff at off-rush hours. But, peak-load pricing is only efficient, if capacity is limited.

Regulation can also take the form of rate of return (ROR) regulation. Many regulatory boards in the US have put limits on the rate of return on capital of natural monopolies, such as electric and gas companies instead of controlling prices directly. However, it might be difficult to determine capital costs, which are composed of annual depreciation allowances and a rate of return on capital. Depreciation allowances can only be calculated, if the length of life of capital goods is known. The determination of the appropriate rate of return on capital invested constitutes another problem. Rate of return regulation can reduce price, but does not render incentives to firms to behave efficiently. Regulated monopolies are often accused of being overcapitalized. That is because they lack incentives to curb capital costs under a rate of return scheme of price fixing, the so-called Averch-Johnson effect (Averch & Johnson, 1962). Another way to regulate an industry involves the use of price caps. The price changes of the regulated industry are linked to price changes of goods in comparable industries under a price cap scheme. Hence, price caps set benchmarks to avoid questions of optimal capital intensity and return rates.

Public utilities often charge identical rates or fees, while costs differ. Cross-subsidization between consumers occurs, if consumers with different costs pay the same price. Cross-subsidization is usually justified by considerations of equal or universal access to public services. Governments usually find it important to offer railroad and telephone services to inhabitants of sparsely populated rural areas and therefore prescribe uniform prices for public utilities. Telephone companies were often obliged to connect inhabitants of remote rural areas at prices equal to those of city dwellers[3]. Cross-subsidization can only be sustained, if the monopolistic supplier is not threatened by entrants. US local telephone services were subsidized by long distance telephone calls for a long time. This situation boosted entry into the long distance market, when

the US telephone market was opened up in 1984. Cross-subsidization is usually condemned by economists, because it violates rules of efficient pricing. This contrasts with their positive opinion on price discrimination, which can contribute to the efficient usage of networks.

3. DEREGULATION AND ENTRY IN NETWORK INDUSTRIES

Privatization and deregulation has emerged during the last decades for several reasons. Deregulation was triggered by new technologies that lacked natural monopoly characteristics. The emergence of mobile telephony in telecommunications is a case in point. Privatization was spurred by the drawbacks of government ownership, such as poor service and immunity to technological progress. A regulated monopoly that does not need to fear entry lacks incentives to increase efficiency and/or increase its service-levels. However, privatization and deregulation may entail the establishment of a private monopoly and cause price increases. Private monopoly power could be curbed, if entry is allowed. However, entry could be prevented, if entry requires large investments in networks. Moreover, actual entry may not spur competition, but could entail monopoly pricing and excess capacity as will be demonstrated below.
A monopoly is called sustainable, if no firm can enter profitably. A monopoly is always sustainable, if price equals average costs (Martin, 1993, 298). Regulation is superfluous in that case, as was demonstrated above. But, entry can also be deterred, if firms pursue a limit price policy. A limit price is defined as the price that makes entry unprofitable. The limit price exceeds average costs by a margin, which is determined by fixed (sunk) costs F. Limit price theory usually assumes that a potential entrant expects the incumbent firm to maintain output after entry has occurred. An equally efficient entrant (that operates on the same cost function as the incumbent monopolist) will then produce ½ (S – Q_m). An entrant will supply half of monopoly output, if the incumbent sticks to monopoly output [3]. Consequently, price-cost margins will be cut in half and an entrant

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[3] Universal access is usually not applied unlimitedly. Inhabitants of remote parts of Sweden for instance did not get fixed telephony connections.
[3] MRe = a- bQm – 2bqe = c : q = ½ (a-c)/b, q = ½ Qm.
Πe = ½ Qm . ½ (Pm - c) = ¼ Πm;

will earn only one quarter of incumbent profits before entry took place. The formula for the limit price is: $P_{lim} = c + 2\sqrt{bF}$.

No firm could profitably enter an industry if price is set slightly below the limit price. Limit price equals monopoly price, if fixed cost amount to one fourth of monopoly profits. We can thus conclude that a hitherto regulated monopolist can deter entry, if fixed costs ≥ ¼ Π_m. Price will exceed average costs and excess profits of three quarters of monopoly profits are reaped, if F = ¼ Π_m.

The appearance of an entrant might trigger different responses from incumbent firms. An entrant has to make conjectures about possible incumbent responses. One possible response is that an incumbent former monopolist maintains output and acts as a Stackelberg quantity leader [4]. An incumbent monopolist could also restrict output and accommodate the entrant. Accommodation would produce a Cournot duopoly equilibrium, in which both firms share the market equally and incur each 4/9th of monopoly profits. But, an entrant will conjecture that the incumbent will prefer to keep output constant after on entrant has arrived, because post-entry Stackelberg profits exceed Cournot duopoly equilibrium profits (1/2 Π_m > 4/9 Π_m). An incumbent can thus credibly deter entry by maintaining monopoly output, if F > ¼ Π_m. An incumbent can also expand output and pursue a limit price policy, if F < ¼ Π_m. A limit price policy will be more profitable than accommodation, if F > 1/64 Π_m and capacity is sufficiently large to supply all customers at this limit price[5].

A potential entrant could also expect an incumbent to collude after it has entered. Price equals monopoly price if firms collude and output remains at the monopoly level. The entrant and the incumbent would share the market equally and receive half of monopoly profits each. Hence, the incumbent monopolist's profits are equal in Stackelberg and collusive equilibrium. An incumbent will prefer to pursue a limit price policy over collusion and/or the Stackelberg outcome, if F > 1/49 Π_m [6]. The expectation of collusion will attract entrants. An entrant firm would earn half of monopoly profits in collusion, but only one fourth of monopoly profits in a Stackelberg equilibrium. Collusion may create excess capacity. Only one fourth of capacity will be used, in

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[4] $P_{stack} = c + \frac{a-c}{4}$, $\Pi_{leader} = \frac{(a-c)2}{8b} = ½\ \Pi_m$;

[5] $\Pi_{lim} > \Pi_{cour}$, if $2S\sqrt{F/b} - 4F > b/9\ S^2$; $F > bS^2/256$.

collusion, if both firms have capacities of Q* (perfectly competitive output). Regulation, therefore, often includes a ban on entry, which is seen as socially wasteful in those cases.

We may conclude that collusion produces the worst outcome from a welfare point of view. Accommodating behaviour (Cournot duopoly equilibrium) would give slightly better results than collusion. Both firms will each supply one third of perfectly competitive output. Entry will also increase excess capacity in this case. Excess capacity will now amount to 4/3th of total capacity, whereas price will decline to 2/3th of the monopoly price. The Stackelberg equilibrium is more beneficial to consumers. Price will decline by half and excess capacity will amount to 5/8th of total capacity. Excess capacity can be reduced even more, if firms pursue a limit price strategy. Excess capacity will amount to $2\sqrt{F/b}$, if firms pursue a limit price strategy. It was pointed out above that an incumbent will be inclined to pursue a limit price strategy, if ¼ Π_m > F > 1/49 or 1/64 Π_m. But, consumers will only benefit from a limit price strategy, if the entry deterring price lies below the price that would emerge, if entry had occurred. Limit price will be lower than Cournot duopoly price, if F < 1/9 Π_m ($2\sqrt{bF} = a/3$) and below Stackelberg price, if F < 1/16 Π_m ($2\sqrt{bF} = a/4$)

Table 1. Strategies, excess capacities and prices*

	P	**Excess Capacity**
Stackelberg	a/4	5/8 S
Cournot duopoly	a/3	4/3 S
Limit price	$2\sqrt{bF}$	$2\sqrt{F/b}$

*It is assumed that marginal costs equal zero.

Hence, entry would actually benefit consumers, if F exceeds the boundary values indicated above. A limit price strategy can create large excess profits. $\Pi_{excess} = 2S\sqrt{F} - 4F - F$. It was mentioned above that excess profits equal 3 times the amount of fixed costs in the case that limit price equals monopoly price. This ratio will increase, if F declines. Hence, excess profits will amount to 11F, if F = b/16Π_m and to 27 F, if F = b/64Π_m. Incumbent monopolists will thus often feel compelled to pursue a limit price

[6] $\Pi_{lim} > \Pi_{coll/stack}$, if $2S\sqrt{F} - 4F > b/8\ S^2$; $F > bS^2/192$.

policy, if their industries are opened up for entry. But, a limit price strategy will only benefit consumers, if fixed costs are sufficiently small ($F < 1/9$ or $1/16\ \Pi_m$). This conclusion applies in spite of the fact that entry will cause large excess capacities.
Our conclusions contrast with some analyses of natural monopoly, in which it is assumed that an equilibrium is only sustainable, if price equals average costs (Brauetigam, p. 1297). Our analysis indicates that markets can be sustainable at prices that largely exceed average costs. However, this conclusion only applies if fixed costs are sunk. Contestable market theory stipulates that price will equal average costs, if markets can be freely entered and exited. A market is called contestable, if investment is non-specific; implying that firms can utilize installed capacity in various ways[7]. Most industries, however, are not contestable. Even the airlines industry, which was long considered to constitute the arch example of a contestable market, displays elements of non-reversibility.
We may sum up by concluding that entry might eliminate profits, but may cause excess capacity. A limit price policy may produce better results, but will not annihilate profits. Regulation, therefore, remains needed in many cases. One way to regulate a natural monopoly is to separate infrastructures from the rest of the industry and put it under governmental control and/or ownership. The establishment of Tennet the company that operates the high voltage electricity network in the Netherlands is a case in point. The regulation of the local loop of the fixed telephony network constitutes another example of a network industry that is (re)regulated.

4. AUCTIONS

It was mentioned above that entry into a deregulated industry can be restricted by large fixed costs. But, entry can also be restricted for technical reasons. The scarcity of frequencies for use in mobile telephony is a case in point. Limits on entry can cause excess profits. Governments can attempt to reap the larger part of the present value of scarcity rents by selling (a limited number of) licenses through auctions. The rights to the use of a network are then sold to the highest bidder(s). A private natural monopoly will have an incentive to curb costs, which a regulated monopoly usually lacks. But, a private monopoly is also induced to raise price above average costs. Hence, franchise

bidding can hurt consumer welfare (Carlton et al, 659). But, this only applies, if natural monopoly industries are sold unconditionally. Rights to exploit a natural monopoly are often granted under restricting conditions. This can involve the execution of a certain itinerary in public transport or a certain service level in garbage handling. A private natural monopoly can also be subjected to price regulation. The prospect of regulation will reduce the expected revenues and thereby the proceeds of the auction, but will enhance consumer welfare.

Licenses can also be distributed via a `beauty contest'. Government then selects one or more firms on the basis of their alleged comparative qualities. Several European governments use beauty contests to distribute UMTS licenses (Spain, Finland, Norway and Sweden). Beauty contests also have their drawbacks. Quality is sometimes hard to discern and favoritism may abound. The government determines the number of (future) competitors, if only a limited number of licenses is issued. A drawback of auctions is that it forecloses entry until the next auction. The absence of the entry threat may encourage collusion.

The creation of a private monopoly could be a sensible strategy, if governments want to curtail the usage of some public utilities for reasons of congestion and environmental protection. This applies to the use of highways and of electricity. Franchise bidding for the usage of highways can reduce usage, if the new monopolist charges monopoly prices. The larger part of monopoly profits can be transferred to the government if the auction was well organized. However, driving a car then becomes restricted to the rich, which is often a politically unfeasible situation. Government does not want to reduce, but -in contrast- wants to stimulate usage of some public utilities such as telephone services and public transport. Competition in telephony can contribute to achieving these goals.

5. (RE)REGULATION OF TELECOMMUNICATIONS

Deregulation of telecommunications became a topic in the 1980s. The US took the lead in telecommunications deregulation with the divestiture of ATT in 1982. The regional telephone companies (Baby Bells) were split off from the interstate telephone company

[7] Another definition of contestability involves that firms can exit from markets without incurring losses.

(Ma Bell). The break-up of ATT resulted in the creation of seven regional telephone companies that replaced the 22 local operating companies. Entry into the US telecommunications markets was opened up in 1976, when the FCC (Federal Communications Commission) granted MCI (a new company) access to the network after a long legal battle. MCI was also given interconnection privileges, which meant that it could use the existing telephone network. Long distance rates declined dramatically after that date. Regulation had allowed ATT to keep long distance rates above average costs to subsidize local service. Cross-subsidization became unsustainable, after the market was opened up. Entry required that entrants were allowed to use the existing network at competitive interconnection rates. A new regulatory authority was installed in order to supervise the interconnection rates.

The European Union initiated deregulation of telecommunications in the late 1980s. The Green Book on telecommunications was published in 1987. More detailed directives followed in 1996 and 1997. The EU set GSM as the first European standard for mobile telephony. New standards were set later, such as the GPRS and the UMTS standards. All these standards represent technological progress and improve the utilization of mobile capacities for both speech and data transmission The European Union had perceived that regulation was required to prevent the exploitation of the fixed network with its natural monopoly characteristics by a private monopoly. The Green Book and the EU Directives advocated the implementation of cost based interconnection tariffs. Hence, regulation remained necessary after privatization. The EU stipulated that newly established national regulatory bodies should supervise interconnection tariffs and that liberalization of telecommunications should be completed in 1998.

The national PTT's in Europe were state-owned companies and needed to be privatized before deregulation could commence. British Telecom was the first European PTT that became a stock quoted company. The Dutch State sold 30 percent of its shares in the Dutch PTT in 1994 and more shares later. It still owned 43 percent of KPN in 2000. KPN as most former monopolists went through an episode of intense restructuring after privatization. It divested its postal services in 1998. It was forced to sell its cable company Casema in 1995 to allow competition between networks. The fixed landline connections are still owned by KPN. But, interconnection tariffs need approval from OPTA; a newly established regulatory authority. Cost-based rate of return (ROR) regulation was used to determine the level of interconnection tariffs. This regulatory

mode has led to various disputes in the past few years. OPTA decided in september 1998 that KPN's rate of return on investment in local telephone services was too high and demanded a tariff reduction of 25%. But, this decision was severely challenged by several economists, the cable companies and by KPN. The companies argued that huge investments were required to accommodate rapidly increasing demand for telephone services due to the Internet. KPN wanted among other things to install new fiber optic lines to connect Dutch cities in a new ISDN network. But, the former national monopolist was rapidly turning into a multinational. Strategic alliances and acquisitions were undertaken to secure positions and access to capital. KPN concluded a joint venture with the US-based Qwest to carry out its investment plans. The new company was divested from its mother and was launched at the Dutch stock exchange in 1999. KPN also executed a capital consuming acquisition policy. It acquired telecommunication companies in Belgium, Germany, Bulgaria, Rumania, Hungary, the Ukraine, China and Indonesia. The former Dutch PTT also incurred large reorganization costs due to the change to a private company. It can, therefore, be questioned whether KPN' s financial issues should be a concern of the Dutch government [8].

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6. (NEW) COMPETITION IN DUTCH TELECOMMUNICATIONS

The Dutch market for fixed telephony was opened up for entry in the mid 1990s. Competition in telecommunications was boosted when new firms got access to the existing network. The market for international telephony was the first to experience fierce competition from new suppliers. Carrier-select companies bought telephone capacity from KPN and competing (international) networks and offered their services at lower rates. Competition induced by carrier select companies was met by KPN that reduced its rates for international telephone services drastically. Carrier select companies have only recently started intense marketing campaigns to expand their market share in local telephony. However, their progress in this market was also arrested by drastic price cuts of KPN. Telephone services to businesses became another area of intense competition. Entrants such as Versatel and MCI have built new infra-

[8] Publieke Belangen en Marktordening; Liberalisering en Privatisering in Netwerksectoren, Nota Ministerie van Economische Zaken, maart 2000.

structures (back bones and city rings) to connect business centers. But their combined market shares did not exceed the 5 percent mark in 2000[9].

Technological progress also enabled other types of networks to supply telephone services. The cable network was originally built to transmit television signals, but it can also be used for telephone and internet services. Cable companies offer their telephone and Internet services mainly on the household market, because most businesses are not connected to the cable network. Diffusion of cable technology is almost complete among Dutch households, but telephone services via the cable network were only offered in a few localities (in 2000). The municipalities owned the cable networks until the early 1990s, when they were privatized. Concentration increased after privatization due to acquisitions. A few large players such as UPC, that had a market share of about 35 percent in 2000 have come to dominate the Dutch cable network (Arnold). However, each cable operator has a monopoly in its own local market. It was mentioned above that the cable companies objected to the interconnection tariff reduction proposed by OPTA in 1998. This seems an obvious reaction, because they have to follow these price cuts, if they want to build up market shares in fixed telephone and internet services. Their (sunk) investments are more valuable, if interconnection tariffs of fixed telephony are set at a high level.

The mobile telephone network constitutes a third network. Hence, new technologies have reshaped the former natural monopoly for fixed telephony into an oligopoly within a decade! Technological progress still proceeds at a rapid pace and will change the landscape of telecommunications further in the near future. Recent developments include the installation of broadband networks by cable and fixed telephone companies (ADSL) and UMTS technologies by mobile phone companies. New services such as e-commerce and pay per view video require these new technologies. New technologies will increase capacities of networks and improve their performance in internet transmission. ADSL will increase capacity of a fixed telephone connection by more than a tenfold of that of ISDN. UMTS technologies will increase mobile telephone capacities by a factor ranging between 6 and 24[10].

[9] NRC-Handelsblad, 21-10-2000. .

[10] A consumer who is connected to a UMTS network has a capacity which is 24 times as large as GSM 900 and 6 times as large as GSM plus GPRS; `Netwerken in Cijfers', Trendrapportage over ICT Infra-structuren 2000'.

All three infra-structures can provide telephone and internet services. It could, therefore, be expected that competition between networks would be particularly fierce in these markets. But, the cable companies had only few subscribers to internet and telephone services (in 2000). Mobile telephony thus poses the most serious competitive threat to the former (fixed) telephone monopolies.

7. STRATEGIC MOVES; VERTICAL INTEGRATION

Many telecom companies have pursued a policy of integration in order to boost demand and deter entry. The acquisition of internet service providers by telephone and cable companies are cases in point. KPN acquired xs4all. Zonnet was acquired by Versatel and Wanado by Casema. Some cable companies founded their own internet service providers. UPC founded Chello and Essent started Excite & At Home.
Internet service providers that offer their services free of charge and receive an income from the network companies (kickback retributions) can also be considered examples of vertical integration. Fierce competition among internet service providers led tot the introduction of `free' internet by World On Line, KPN (het NET), ING (Freeler) and many other companies in 1999. Vertical integration of internet services and network usage seems to constitute an interesting strategy as is testified by the numerous companies that have pursued it.
The acquisition of Time/Warner and Netscape by America on Line (AOL) and Endemol by Telefonica in the spring of 2000 constituted an integration strategy of a somewhat different character. AOL wanted to obtain content, when it acquired Time/Warner, which differs from integrating telephone and internet services. The difference lies in the possibilities for product differentiation that the possession of content provides. Both telephone and internet services constitute rather homogeneous products. But, the internet supplier that can differentiate its portal by offering interesting content may attract more customers. Moreover, the AOL/Time Warner combination could monopolize its content. Music producers have filed a complaint on the upcoming merger with the EC Commission. They wanted access to the music of AOL/Time Warner under competitive conditions. Another example of a strategy that combines content and hardware constitutes the acquisition of television channels by cable companies. The attempt by UPC to acquire the television channel SBS 6, is a case in point. The deal collapsed, because UPC's stock price had declined below the agreed

upon acquisition price. However, UPC still possesses a minority share in SBS 6 and strategic alliances between UPC and SBS 6 have been concluded. This development has attracted the attention of Dutch policy makers. The Dutch government expressed the opinion that new regulation might be warranted to prevent abuse of monopoly power by the cable companies [11]. Cable companies like UPC will possess (local) monopoly power in television broadcasting for some time to come, because new technologies such as digital air-transmitted television are not expected to appear in the near future.

It is interesting to assess the effects of vertical integration in cable television on diversity. It will be demonstrated below that the effect of vertical integration on the number of channels that are transmitted is ambiguous. Industrial organization theory teaches that vertical integration is an interesting strategy to increase both profits and consumer welfare in the case of two successive monopolies. But, integration will increase profits and reduce social welfare, if monopoly is involved in only one product (Sonnenschein).

The double monopoly case will be discussed first. We assume that the cable company possesses a monopoly. It obtains revenues by selling subscriptions. The subscription price includes a certain number of television channels apart from the use of the fixed network. It is further assumed that consumers prefer variety in the sense that their utility is doubled, if the number of networks they receive doubles. Networks are completely horizontally differentiated. Each broadcaster thus has a monopoly in its own genre. It is also assumed that cable companies need to pay a fee to independent television channels. Demand for each transmitted television network depends on subscription price as is expressed by the (inverse) demand function: $P = a - Q$.

It is assumed those marginal costs of both the cable and the channel company equal zero. The television network charges the cable company a fee of a magnitude d per subscriber. The cable company will maximize its profits $\Pi_{cable} = (Pc - d)Q$. Hence, it will sell $Q = (a-d)/2$ subscriptions and charge consumers $P = (a-d)/2$ per subscription [12]. The television network will maximize $\Pi_{tv} = dQ = d(a-d)/2$ and set its price d at ½ a [13]. The number of subscribers will then amount to ½ (a – ½ a) = ¼ a. Hence, the cable company will charge subscription prices per channel of :

$P = a - Q = a - ¼ a = ¾ a$..

[11] `Kabel en Consument, Marktwerking en Digitalisering'.

[12] Marginal revenues = $a - 2Q - d = 0; \rightarrow Q = (a-d)/2$

[13] Marginal revenues minus marginal costs = $(a-2d)/2 = 0: \rightarrow a-2d = 0; \rightarrow d = a/2$

Profits for the cable and the broadcasting companies can be calculated as follows:

Π_{cable} = (P-d)Q =(¾ a – ½ a) ¼ a = $\frac{a^2}{16}$

Π_{tv} = dQ = ½ a. ¼ a = $\frac{a^2}{8}$.

Total profits thus amount to $\frac{3a^2}{16}$

An integrated monopolist, however, would only demand a price of ½ a and would accordingly have twice as many subscribers. Integration would benefit the company, because its total profits would now amount to $(a-c)^2/4$. Consumers would also benefit, because monopoly price of ½ a lies below the non-integrated price of ¾ a. Hence, consumers could receive fifty percent more channels, for the same subscription fee!

Our analysis makes us conclude that especially cable companies can increase revenues by acquiring television networks. Their revenues are doubled by integration, if we assume that monopoly profits are equally split between networks and cable companies. Consequently, television networks can only benefit from vertical integration, if they receive some of the benefits of integration from the cable company. Vertical integration can thus increase efficiency and diversity.

The Dutch situation differs from the picture sketched above, because the cable companies do not pay a fee to independent channels. In contrast, channels that were not included in the package such as CNN were even demanded to pay the cable companies a transmission fee, which CNN refused. This situation can be explained by regulatory measures. Dutch cable subscription prices are set at a relatively low level. The contents of the basic package are also determined by regulatory agencies and not by market forces. Obviously, cable companies are not interested in putting an extra channel on the cable, if they cannot charge consumers for more diversity. The Dutch situation originates from the past where households paid an obligatory fee (omroepbijdragen) for a certain package. The above analysis would, therefore, only apply, if cable companies can charge consumers for the transmission of (extra) television networks.

Cable companies have consistently pursued a bundling strategy, as has been demonstrated by their (attempted) acquisitions of internet service providers and television networks. But, vertical integration can also deter entry due to foreclosure effects (Shy, 176-79). Entry of new internet service providers and television networks is deterred, if cable (or telephone) companies only allow their own companies on the network and exclude others. However, the Dutch government intends to force the cable

companies to admit independent internet providers on their network in 2002. However, foreclosure can still occur, if network companies charge prices that would make entry unprofitable. Regulation of cable tariffs seems necessary to prevent foreclosure through high prices.

Cable companies may lose their monopoly on television transmittance due to the emergence of competing technologies, such as digital air transmitted television. Households would then have a choice between competing networks. However, the digital newcomer can be put in an unfavourable position vis a vis the cable company. Firstly, because cable companies can refuse to transmit their (popular) channels to the new digital network, which can then only offer a limited package of channels. An entrant might establish its own television networks, but this would increase investment costs. Anti-trust suits filed by US satellite companies have led to legally enforced transmission of integrated television channels in some cases. However, this would not help emerging networks much, if cable companies can charge new television networks monopoly prices.

The effects of vertical integration in a duopoly in infra-structures are demonstrated below. The physical network market is assumed to constitute a duopoly with equal market shares for both cable and satellite network companies. . It is assumed that both television networks and cable/satellite companies incur no marginal but only fixed costs. The television network is a monopolist. Applying a Cournot duopoly quantity setting model demonstrates the effects of vertical integration. Market shares of firms in a Cournot duopoly equal:

$q_i = \frac{a - 2c_i + c_j}{3}$.

The television network would maximize its profits before integration by charging the cable and/or satellite company a price c_{tv} per subscription of a/4 as is demonstrated below:

$\Pi_{tv} = c_{tv} q_{cable} = c_c (a - 2c_c + c)/3$

$\frac{\partial \Pi}{\partial c} = a - 4 c_c = 0;\ c_c = ¼\ a.$

$q_{cab} = q_{sat} = \frac{a - a/2 + a/4}{3} = a/4$

$P = a - Q = a - 2. ¼\ a = ½\ a$.

We can, therefore, conclude that in a price of ½ a for a package of hardware and software would be charged, if broadcasting rights need to be bought from a monopolistic television network. The situation would alter, if the television network

were acquired by one of the two `hardware' networks. We will assume that the cable company acquires the television network. It is demonstrated below that the non-integrated satellite network will sell fewer subscriptions and incur lower profits than its integrated rival. In fact the integrated cable company will have 2,5 times as many subscribers as the non-integrated digital network company. The non-integrated satellite network company will pay the same price of a/4 for transmission. But, the integrated cable company will pay a price of zero and thus incurs zero marginal costs.

$q_{cab} = \frac{a - 2c_c + c_s}{3} = \frac{a + a/4}{3} = 5a/12$

$q_{dig} = \frac{a - a/2}{3} = a/6$

Price of the package will amount to a – 7/12a = 5/12a, which is slightly below the price of a/2 that we had obtained for the non-integrated situation The cable company will make profits of $(25\ a^{2)}/144$, whereas the digital network only incurs profits of $a^2/36$[14]. We could, therefore, conclude that vertical integration benefits consumers. But, vertical integration could turn against consumers, if the satellite company disappears from the scene. The competing technology can be foreclosed, if its fixed cost exceed $a^2/36$. Price will increase to a/2, if the digital satellite network disappears. This equals the duopoly price in the absence of vertical integration analyzed above. We can thus conclude that vertical integration only benefits consumers, if foreclosure does not occur. However, the integrated physical network can always deter entry by increasing sunk costs to a little over 40 percent of its gross profits. A policy that bans such vertical mergers and acquisitions seems, therefore, recommendable.

It seems best to sell subscriptions for infrastructures and television networks as separate products. Digital and cable companies then have equal chances to obtain subscribers. The television network is still assumed to be a monopolist in its own genre, whereas infra-structural services are provided by a duopoly. The demand curves for both television and hardware services are P = ½ a – Q.

The television network will maximize it profits, if it charges a monopoly price P_{tv} = a/4 and get a/4 subscriptions. The hardware companies will charge a duopoly price P_{hard} = a/6. Hence, subscribers will now pay 5/12a for one television network plus the use of

[14] Π_{cable} = 5/12 a . 5/12 a ; Π_{dig} = (5/12 a – ¼ a)1/6 a

the physical network[15]. We can note that this exactly equals the price we found above for a situation of incomplete vertical integration analyzed above. But, the unbundled situation seems preferable to that of incomplete vertical integration, because consumers can now express their preferences for television networks directly and subscribe to the channels of their own choice.

We can conclude from our analysis on vertical integration that vertical integration only benefits consumers, if competition between infra-structural networks remains intact. However, a policy of unbundling seems most recommendable to stir competition between physical networks and increase variety.

8. STRATEGIES IN MOBILE TELEPHONY

Mobile telephone services constitute another and until now more important alternative for the fixed telephone network. Mobile telephone networks are less capital intensive than landlines. The investment costs per UMTS connection amount to 240 $ per connection, whereas a HDSL connection costs 1980 $ and an ISDN-BA connection 1375 $[16]. We can conclude from these figures that fixed investments in mobile telephony amount to less than one fifth of ISDN and less than one eight of HDSL connections.

These figures could make us conclude that that mobile telephony does not constitute a sustainable monopoly, since $F_{mob} < ¼ F_{fix}$. This conclusion would apply, if profits of mobile telephony equal those of fixed telephony. ADSL is somewhat cheaper and constitutes a serious competitor to mobile phone companies, if consumers consider fixed and mobile telephony rival products.

KPN is the only firm with stakes in both fixed and mobile telephony in the Netherlands. It intended to divest its mobile telephone division and launch it as a separate company on the Amsterdam Stock Exchange in 2000. Such a divestiture might have clarified the competitive situation between KPN and the other suppliers of mobile telephone services. The IPO was, however, postponed after stock prices dropped sharply in march 2000. KPN concluded an alliance with the Japanese telecom company NTT Donomo in

[15] It is assumed that consumers are subscribed to more than one television network and to only one physical network.

spring 2000 that acquired a minority share of 15 percent in KPN Mobile after an attempt of KPN to merge with Spanish Telefonica had failed.

KPN obtained the first license for mobile telephony in 1989. The first GSM licenses were issued to both KPN and Libertel (Vodafone) in march 1995. The Dutch authorities selected Libertel as a second provider in a `beauty contest, which left several international consortia empty-handed. The Dutch government decided to allocate future licenses through auctions. An auction for a third GSM license scheduled for 1997 was cancelled. A new auction was organized in february 1998 in which several entrants bid for 2 full licenses. Three new entrants arrived on the scene in 1998: Telfort, Dutchtone and Ben. The third entrant (Ben) could enter, because it obtained a number of smaller frequencies from two different parties [17]. The price of a complete license amounted to 600 million guilders. The two-stage licensing process in the Netherlands had several consequences. The auction price of the new licenses brought the new competitors in a disadvantageous position vis a vis KPN and Libertel, which had obtained their former licenses free of charge. These newcomers were also handicapped due to the time that had passed (3 years) between the first and second round of issuing. The Netherlands counted 5 suppliers of mobile telephony as a consequence of the GSM auction, whereas other European countries only counted 3 or 4 suppliers. These 5 companies have supplied the Dutch market for mobile telephone services from 1998 until this date (2000). All 4 entrants are subsidiaries of multi-national telecom companies. Suppliers of mobile telephony require big pockets to finance their huge investments in spectrum licenses, infrastructure and marketing. Big profits are expected to lie ahead due to the rapid diffusion of mobile telephony. The number of mobile callers exceeds that of fixed telephony. This is because mobile telephony is person-related, whereas fixed telephony is household-related. New technologies such as WAP (Wireless Application Protocol) will make wireless telephony suitable for the internet, which can expand its usage far above current levels.

KPN remained dominant in the Dutch mobile telephone market. It had a market share of somewhat over 50 percent at the end of 1999. Libertel ranked second with about 30 percent and the 3 midgets Ben, Dutchtone and Telfort all had market shares below 10

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[16] `Netwerken in Cijfers 2000', Trendrapportage van het Ministerie van Verkeer en Waterstaat. The Hague.

[17] Kamerstuk 24095, nr 55. `Frequentiebeleid', Brief van de staatssecretaris en de Minister van Verkeer en Waterstaat, d.d. 4 september 2000

percent [18]. Dutch market structure in mobile telephony can be interpreted as the result of a two-staged Stackelberg leader-follower model. It was indicated above that an incumbent monopolist would be inclined to behave as a Stackelberg leader, if it was confronted with one follower. However, it would be indifferent between leadership and accommodation, if a second follower would appear. The best response function of the second follower would be:

$2q = (1 - 1/2 - 1/4)\ S ; \rightarrow q = 1/8S$. The former monopolist would incur profits of $1/8bS .1/2\ S = b/16\ (a-c)^2$, which equals profits of a three firm Cournot equilibrium. But, the situation changes, if firms appear bunch-wise. A Stackelberg leader would maintain its monopoly output, if it is followed by two entrants that appear simultaneously (Martin, 2000).Best response function of each follower is:

$2q_f = S - q1 - q_f:; \rightarrow 3q_f = S - q1: \rightarrow q_f = 1/3\ (S - q1)$.

Firm 1's residual demand function:

$P = a - bq1 - 2bq_f$; $P = a - bq1 - b/3\ (S - q1)$:

The incumbent monopolist maximizes its profits (P-c)q1:

$(2b/3\ S - 2/3\ q1)q1$;

$MR - Mc = 2b/3S - 4/3\ q1 = 0; \rightarrow q1 = ½\ S$

The former monopolist would thus maintain its output and reap profits of $1/3\ \Pi_m$, which exceeds Cournot profits in a three firm oligopoly ($=1/4\ \Pi_m$.). It can be proven that a Stackelberg leader will always be better off supplying monopoly output irrespective of the number of followers, if they arrive simultaneously[19]. But, a former monopolist would be inclined to accommodate, if two or more entrants would arrive sequentially. A combination of simultaneous and sequential entry will give case-specific results. The Dutch situation where first one and then 3 entrants appeared favours Stackelberg behaviour. A Stackelberg model would predict that Libertel would enter at half of KPN's size. The three followers that arrived simultaneously at a later date would each enter at one eighth of KPN's size in such a Stackelberg model .

$P = a - Q$, $c(q) = F$,

Market share KPN = $\frac{a-c}{2b}$; Market share Libertel = $\frac{a-c}{4b}$

Best response function for each of 3 newcomers;

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[18] Ministerie van Verkeer en Waterstaat, `Verkenningen'op. cit. 35.

[19] $\Pi_{stack} = b/(4n)\ S^2 > \Pi_{cour} = \frac{bS^2}{(n+1)^2}$ for $n > 1$.

$2q = (1 - ½ - ¼)S - \frac{(a-c)}{4b} - 2q;$

$\rightarrow 4q = S/4 \rightarrow q = \frac{a-c}{16b}.$

A leadership strategy is more profitable than an accommodating strategy under these conditions. Each firm would incur profits equal to $bS^2/36$ in a Cournot oligopoly counting 5 firms. But, KPN's profits in the Stackelberg equilibrium amount to $(a-c)/(2b) \times 1/16 (a-c) = bS^2/32$. KPN 's strategic choice to remain dominant seems therefore a rational response in the Dutch market situation. KPN's leadership strategy could explain why KPN matched the price cuts of its rivals. The new entrants started a price war in 1999, but KPN responded rapidly and the market shares of the three newcomers remained small. Telfort started a new price war in the spring of 2000. It had 500.000 subscribers in march 2000 and wanted to expand this number to 1 million within the year 2000. However, KPN again reacted quickly and lowered its tariffs. It could be argued that neither KPN nor Libertel were inclined to give up market share to accommodate the three newcomers.

Dutch mobile market structure differed from UK and German market structures. British Telecom and Vodafone had both shares of about 30 percent of the UK market in april 2000; the time of the UK UMTS auction. Orange (Vodafone) and One2One had rapidly increased their market shares up to about 20 percent at that time. The German GSM market was also more equally distributed than the Dutch. The German market leaders Mannesmann (Vodafone) and Deutsche Telekom both had market shares of about one third of the market. E-Plus (KPN) had a market share of somewhat above 20 percent, whereas VIAG's market share lied below 10 percent.

Italian and Austrian mobile markets resembled the Dutch market. Telecom Italia (the former monopolist) had a market share of over 50 percent at the close of 1999, whereas his runner-up Omnitel (Vodafone) had a market share of about 30 percent. Wind and BLU (BT/Benetton) only occupied small market shares. The Austrian former PTT Mobilkom also had a market share of over 50 percent, whereas the second supplier Deutsche Telekom possessed more than 25 percent before the UMTS auction began in november 2000. Two other firms owned by Deutsche Telekom and Teledanmark held small market shares.

Hence. some former monopolists such as Brithish Telekom and Deutsche Telekom had lost dominancy whereas KPN, Telecom Italia (Tim) and Mobilkom had not.

The differences in these markets, which all featured 4 GSM suppliers could be explained by the way entry was staged. A Stackelberg policy is more attractive than an accommodating policy in a four firm configuration, if at least two of the three entrants arrived simultaneously. However, accommodation would have been the best incumbent response, if all three entrants would have arrived sequentially ($bS^2/24 > bS^2/25$).

9. EUROPEAN MOBILE MARKETS AND SPECTRUM AUCTIONS

Differences in market structure could be explained by the number and sequence of entry as was noted above. Leadership strategies could also explain why Dutch and Italian mobile telephony tariffs lied below UK and German tariffs that were more than 50 percent higher. Tariffs for private use were much lower than for business use in all Western European countries[20]. It will now be demonstrated that GSM market structures set the stage for UMTS auctions. Western European governments all issued 4 to 6 UMTS licenses through auctions or beauty contests [21]. These numbers are induced by technical considerations. Frequencies up to 145 mHz can be auctioned. Dutch, German and Austrian governments set 25 mHz apart and put 120 mHz on auction. This 120 mHz can be split up in three different ways. It can be split in 6 lots of 20 mHz; 4 lots of 30 mHz or in 5 lots; 2 of 30 and 3 lots of 20 mHz. Dutch spectrum frequencies were divided in two lots of 30 (plus 5) and three lots of 20 (+5) mHz. The german UMTS auction endogenized the number of licenses that were issued. Twelve spectrum blocks of 10 mHz were auctioned in Germany in august 2000. Firms could bid for either 2 or 3 blocks, so that either four or 6 equal sized firms or 5 firms of two different sizes could emerge. The Austrians followed the same procedure in their november 2000 auction. The UK government partitioned the available space in 5 lots: one lot of 35 mHz was reserved for a newcomer. The remaining 4 lots were partitioned in one lot of 30 and three lots of 25 mHz. The Italian government auctioned 5 licenses of 25 mHz each in october 2000. The remaining frequencies were reserved for newcomer(s) at a fixed price. The UK, Germany, Italy and Austria all counted 4 incumbents. All auctions were

[20] Kamerstuk 24095, nr 55 tabel 1. Measurement date is march 2000. The UK private rates were almost twice as high as the Dutch.German private rates were 50 percent above the Dutch.

[21] Auctions were organized in the UK, the Netherlands, Germany, Italy and Austria on this date (november 2000). Denmark and Switzerland intended to auction their UMTS licenses.

organized as ascending auctions and each firm (consortium) could only obtain one license. Hence, in all auctions except the Dutch the number of licenses exceeded the number of incumbent suppliers. We can wonder whether the Dutch government made a wise choice by creating these lot sizes?

To answer this question we will first address the issue of the effects of market structures on profits in a Cournot oligopoly model. This can give us some insight in the amount of fixed costs that would make a market of five sustainable. We assume a demand curve for fixed telephony that fits P = a - Q and marginal costs for fixed telephony that equal zero. Consumers' preferences for mobile telephony are assumed to exceed those of fixed telephony but mobile telephone companies need to pay an interconnection tariff to owners of fixed infrastructures equal to c. It is assumed that higher reservation prices for mobile telephony are just sufficient to cover this marginal cost. Hence, the demand function for mobile telephony is P = (a + c) - Q

Each (equal-sized) supplier of mobile telephony will make profits of $a^2/(n+1)^2$ It is assumed that fixed (sunk) capital costs of a mobile network are assumed to amount to one fifth of the fixed landline network. Fixed telephony constitutes a natural monopoly and the price of fixed telephony under average costs regulation would equal:

$P_{fix} = ac = F/Q$; $\Pi_{fix} = F_{fix} = Q^2$; $Q_{fix} = \sqrt{F_{fix}}$;

A long run equilibrium in mobile telephony will be established, if the price of mobile telephony equals average costs:

$P_{mob} = ac_{mob} = F_{fix}/ 5q$

$F_{mob} = \Pi_{mob} = q^2$; $q = \sqrt{Fmob} = \sqrt{\frac{Ffix}{5}}$

The number of equal sized firms in a (Cournot) long run equilibrium can be calculated in the following way: (N +1)q = S.

$N_{mob} =$ a-c / $\sqrt{\frac{F_{fix}}{5}}$ - 1 = 5

$\rightarrow$ a-c / $\sqrt{\frac{F_{fix}}{5}}$ = 6 ; $\rightarrow F_{fix}/5 = \frac{(a-c)^2}{36} = 1/9\ \Pi_{m.}$

Hence, five mobile phone companies can only be sustained in long run equilibrium, if fixed (sunk) cost of fixed telephony $\leq 5/9\ \Pi_m$.

Profits might exceed average costs, if firms collude. It was mentioned above that the government determines the number of licenses that are sold at periodic auctions. Entry is thus prohibited in between auctions. The absence of the entry threat could induce

firms to behave collusively. Profits of mobile phone companies would increase by fifty percent, if companies would collude instead of compete:

$\Pi_{icour} = \frac{(a-c)^2}{36}$;

$\Pi_{icol} = \frac{(a-c)^2}{6.4} = \frac{(a-c)^2}{24}$

Another, more competitive situation might occur, if mobile telephone companies could all operate the same network. Fixed costs per mobile firm will then amount to $F_{fix}/ 5N$.

$\Pi_{mob} = q^2 = \frac{F}{5N}$; $q = \sqrt{\frac{F}{5N}}$

$N_{mob} = \frac{a-c}{\sqrt{\frac{F}{5N}}} - 1$; $N_{mob} = a\text{-}c : \sqrt{\frac{(a-c)^2}{36N}} - 1$;

$N^2_{mob} - 36\ N + 1 = 0$; $\rightarrow N = 35.95$.

The industry can thus support almost 36 firms if they can share a common network that possesses sufficient capacity to meet demand at competitive prices. But, the industry would constitute a natural monopoly under these conditions and regulation would be called for to prevent the emergence of excess capacity. Mobile telephony does not constitute a natural monopoly, because capacity in mobile telephony is restricted. A mobile supplier needs a large spectrum to supply all consumers. As a consequence a firm's market share is limited by the capacity of its license. That is why large spectrum licenses are worth more than small ones.

We will assume that future market shares are proportionate with lot sizes. Profits of mobile telephone companies will depend largely on the number of competitors in a Cournot model. Profits are almost halved, if the number of equal sized competitors rises from 4 to 6.

$\Pi_{i\ cour} = \frac{(a-c)^2}{(n+1)^2}$

$n = 4$; $\Pi_{icour} = \frac{(a-c)^2}{25}$, $n = 6$; $\Pi i_{cour} = \frac{(a-c)^2}{49}$

We could, therefore, assume that firms incur profits that are almost twice as large in the case of a four instead of a six firm Cournot equilibrium.

Profits in the 5 firm case with unequal market shares would differ for large and small firms. The ratio of profits could vary with q or with q^2. Profits would vary with q, if profit margins were equal for large and small firms. But each firm would earn $(P\text{-}c_i)q_i =$

q_i^2 in a Cournot setting where market shares reflect cost differences. Profits for each lot would then amount to:

q = 35 Megahertz: Profits : 1225
q = 30 Megahertz: Profits : 900
q = 25 Megahertz: Profits : 625
q = 20 Megahertz: Profits 400

This exercise allows us to predict that a 20 mHz lot would only be worth one third of a 35 mHz lot, if lots of unequal sizes are put on auction. We compared our hypothetical results with the actual results obtained on the 4 auctions that took place in 2000. The results of the 4 auctions were as follows:

Table 2
UMTS AUCTION REVENUES 2000

Country	**UK**	**Netherlands**	**Germany**	**Italy**	**Austria**
Lot size					
35	7,4	1,6 + 1,6			
30	10				
25	6,7,+ 6,8 + 6,9	1,0+ 0,9+0,9		12 / 5	
20			6 times 8,5		0,7/6
Total	37,8	6	51	12	0,7

All prices are in billions of Euro.

It can be noted that prices of lots of equal size did not differ much within countries. This supports our argument that license values are related to lot sizes. The price ratio's of lot sizes fall within our theoretical ratio's. KPN and Libertel paid 1,75 times as much for their large licenses as Telfort, Ben and Dutchtone did for their small ones. The theoretical ratio ranges from 1,4 to 1,96 in this case. The British 35 lot was sold at a relatively low price to TIW (the entrant), whereas Vodafone paid almost 1,5 times as much for its 30 mHz license, which exceeded the theoretical ratios ranging from 1,2 to 1,44. We can conclude that these figures are closer to the upper than the lower bound of our theoretical ratio's, which indicates that large lot sizes imply cost advantages. The awkward relationship between the prices paid for the 30 and 35 lots in the UK indicates that incumbents valued a large lot more than entrants which was to be expected.
We can thus conclude that price differences between lots within countries can be largely explained by size differentials. However, it is more difficult to explain why UMTS auction results differed largely between countries.

Table 3
UMTS 2000 AUCTION REVENUES PER CAPITA (Euro's)

United Kingdom	635
The Netherlands	170
Germany	615
Italy	210
Austria	144

The UK and German auctions obtained much higher revenues per capita than the Dutch, Italian and Austrian auctions. Differences in lot sizes could explain these differentials to only a small extent. Another explanation could be that profits per capita differ among countries. Frequencies of countries with relatively low prices such as Italy and the Netherlands could be less valuable for this reason. Moreover, accommodation in UK and German GSM markets led to more equal market shares as was demonstrated above. This expanded the advantages of incumbency and made that the large lots were more heavily contested. Differences in auction design involve another explanation. Government revenues will only be maximized, if firms feel compelled to bid up to their expected discounted profits. Auctions will only produce good results (from a government point of view), if the number of contestants does not equal the number of licenses. Some experts say that the number of licenses should exceed the number of incumbents at least by one in order to attract entry (Klemperer). Entrants will otherwise eschew entry, because incumbents are expected to value a license more than an entrant. An incumbent will lose its former investment, if it does not succeed in obtaining a license. Moreover, it takes time before an entrant has built a network and a customer base. It could, therefore, also be argued that auctions would provide even better results, if fewer licenses are issued than there are incumbents. Such a situation would force at least one incumbent to withdraw, whereupon his (sunk) assets would become obsolete. No government wanted to stage an auction where the number of incumbents exceeded the number of licenses issued. Incumbents could have sued them for damages. A number of licenses that exceeds the number of incumbents has the additional advantage of widening market structures, which could boost competition. Paul Klemperer explains the success of the UK auction by the fact that five licenses were put on auction, while there were only four incumbents. He ascribed the even better result of the German auction to luck rather than design (Klemperer, 2000, 10). I disagree with the latter statement, as will be elaborated below.

This principle of incumbents plus one (N+1) licenses was violated by the Dutch auctioneers who put 5 licenses on auction in july 2000. The number of potential entrants had already declined to one (Versatel) shortly before the auction started. Versatel withdrew after it was charged by Telfort to drive up prices only to harass incumbents. More than one entrant needs to enter the auction, if licenses number N + 1. The Italian auction, was therefore a risky affair with 6 participants (4 incumbents and 2 entrants) bidding for five licenses. The incumbent BLU withdrew early from the Italian auction leaving room for two new consortia (IPSE and Andala). This seems to contradict the wisdom that incumbents value licenses more than entrants. But BLU had only obtained a market share of less than 3 percent. Moreover, entry might have been made too attractive due to the extra frequencies that were reserved for newcomers.

The good results of the UK auction could be explained by the large number of contestants (13) that bid for five licenses The German auction where 7 contestants bid for a maximum of 6 licenses seems to contradict this contention. However, the German auction demonstrates that auction outcomes do not only depend on the divergence between numbers of contestants and licenses but also on differences in lot sizes.

It was shown above that large (35 mHz) frequencies could be worth 3 times as much as small ones (20 mHz). Hence, firms will bid up for large licenses, if the number of large firms exceeds the number of large licenses. The importance of this competition for dominance is testified by the result of the German auction where 6 firms continued to bid up, after Debitel had left. German revenues were increased by 18 billion Euro, (more than one third of total auction revenues). Hence, neither Mannesmann (Vodafone), nor Deutsche Telekom or E-plus was prepared to give up their ambitions of dominance. This was to no avail, since 6 licenses were issued at the close of the German auction. Hence, firms only acknowledged defeat after they had spent 18 billion Euro in an attempt to beat their rivals. That dominance is worth a high price is also testified by the UK auction where British Telecom and Vodafone drove up the price for the 30 mHz spectrum. The intensity of competition might be explained by the small difference in market share between Vodafone and BT.

But, competition for dominance did not occur in the Netherlands. The relatively large market shares of KPN and Libertel and the fact that two large licenses were auctioned might explain this. The price that is paid for each lot in an auction equals the valuation (plus ε) of the bidder that withdraws last. Large lots will, therefore, only obtain high prices, if the number of bidders for each lot size exceeds the number of licenses. But,

the three small Dutch competitors were satisfied with a small license and did not challenge the big guys. It was argued that the absence of roaming rights regulation inhibited competition on the Dutch UMTS auction and contributed to the disappointing results [22]. The 3 late arrivers had built smaller networks and could only roll out their UMTS network if they could (temporarily) use KPN's or Libertel's GSM network. However, much will depend on the prices small firms have to pay for the use of a dominant firm's network and the capacity they can demand. It could be argued that the disappointing result of the Dutch auction could have been prevented, if the Dutch government had auctioned only one large lot and 5 small ones. This would have stimulated competition between KPN and Libertel for the large lot and between the three small incumbents and newcomers for the small lots. Hence, the price of the large lot would then have been determined by Libertel's and the price of the small lots by Versatel's valuation. But, the way the Dutch auction was designed made that the price of the large lots was determined by the valuations of the three small incumbents. The price of the small lots was determined by Versatel that felt compelled to withdraw.

The German auction was very ingeniously designed from a quest for dominance point of view. It could be expected that all four incumbent firms would try to achieve or maintain dominance by bidding for a large lot of 30 mHz. However, entry competition would prevent the occurrence of such a result. Firms would then bid up to achieve one of the two glittering prizes of a five firm outcome. But, it turned out that incumbent firms would not let the other win such a prize. .

The disappointing result of the Italian auction can be contributed to the small number of contestants and the equal lot sizes. There were no big prices to gain and the price of each lot was thus established at the level of Benetton's valuation, which was relatively low due to its small market share.

The small number of participants can explain the disappointing result of the Austrian auction. There were only 6 bidders for a maximum of 6 licenses. The desire to maintain (or establish) dominance is, therefore, the only factor that can explain why Austrian licenses were sold 15 percent above the minimum price. But, competition for market share did not ignite. Six licenses of 20 mHz were sold on the second day of the auction. It would have been plausible, if market leaders Mobilkom and Deutsche Telekom had bid up to obtain three instead of two lots. Their bids would not have been heavily

[22] This opinion was expressed at several occasions by Jens Arnbak the chairman of

contested, if the small competitors were not intending to increase their market shares. However, both firms did not seriously try to maintain dominance. The remarkable outcomes of the Dutch and Austrian auctions rose suspicions of collusion.

10. CONCLUSIONS

Telecommunications has changed from a regulated monopoly into a competitive industry within a decade. Technological progress has largely demolished the natural monopoly characteristics of telecommunications, although pockets of monopoly power remain present, f.e. the local loop in fixed telephony. Regulation remains needed to assure access to these networks.

Private firms have developed strategies of bundling and vertical integration to improve profitability and deter entry. Regulation and/or desintegration may be warranted to facilitate entry of competing networks. Competition between networks is most virulent in telephony, but could emerge in television. Competition on the same network seems only possible for mobile telephony. Market structures in mobile telephony are largely determined by licensing practices. The paper demonstrates that auction outcomes also depend on size differences between spectrum frequencies in relation to incumbent market shares.

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