Chapter 9

Cost and Demand Characteristics of Telecom Networks

Morten Falch

1.0 Introduction

One of the main reasons to undertake sector specific regulation of telecom markets has been the unique characteristics of cost and demand structures within the telecom sector. This chapter examines some general characteristics of cost and demand for telecom services, and on this background discusses how these affect possibilities for creating competitive telecom service markets.

One important economic reason for regulation is to help achieve the optimum level of production from a societal point of view, i.e., to ensure production of the desired products and services in the desired quantities and at appropriate prices for all consumers desiring them. The need for regulation depends on the ability of the market to create this situation by itself. The first basic question is whether production should be organised as planned production with possible corrections by the market, or production should be determined by the market with possible corrections from planners or regulators.

Historically, service production in the telecom sector has been organised by a monopoly network operator, selling its services on a market. In many cases the operator has been a part of the public sector and financial profitability has been only one of several objectives. The role of regulation in this situation has been to ensure that the monopolist behaved in accordance with the public interests and did not misuse its monopoly position.

The primary economic argument for this institutional set up was that a single operator would be able to provide services at lower rates and with a wider coverage than a market with a number of competing operators. A single operator is in a better position to dimension and plan the construction of the network (technical efficiency) and to avoid duplications of investments and excess capacity. Thereby economies of scale can be fully utilised to the benefit of all customers. In addition a single network operator can better ensure compatibility of all parts of the network, and technical and administrative costs related to network integration and interconnection can be minimised.

The experience with this institutional set up has been rather mixed. In practice it has been very difficult both to control tariffs and to ensure high productivity. And the pressure to allow new operators into the market has increased, especially in a situation with rapid technological advances and development of new products. The monopoly operators often have proved unable to meet customer demand in a satisfactory way. Competition sets a downward pressure on tariffs and encourages operators to avoid

organisational slack. In addition, competition will motivate operators to innovate, to become more efficient and to be the first to introduce new services.[1] It is argued that competition can ensure development of telecom services much better than attempts at strict regulation of a monopoly.

The disadvantage is that the above mentioned advantages of technical efficiency, economies of scale, and low interconnection costs at least partly will be lost. The economic balance between the advantages and disadvantages of more competition (depicted in Table 1) has been the main conjecture in telecom regulation for decades, but there is now a general consensus in favour of more competition. Today government policy and regulatory authorities in almost every country aim to introduce more competition into their telecom industries.

Monopoly:	**Competition:**
Economies of scale	Organisational efficiency
Technical efficiency	Pressure on tariffs (prices)
Low interconnection costs	Innovativeness
Public Interest Objectives	New Service Development

Table 1 – **Monopoly vs. competition**

The question is how more competition can be realistically obtained that is likely to bring beneficial results. A fully liberalised market will not necessarily by itself lead to more competition. This depends very much on supply and demand factors that shape market conditions. This chapter examines these conditions and their potential impact on the competition that is likely to develop.

2.0 The Cost Structure of a Telecom Network

The telecom sector is characterised by very large investment costs. The precise percentage of total costs attributed to investments depends of course on the definition of investments and of telecom activities (e.g. whether research, marketing or similar activities are included). Although some sources claim investment, and investment-related costs to be as much as 90 percent of the costs of production[2], most estimates based on financial data, however, vary between 60 and 75 percent.

Thus, by all measures the telecom sector is comparatively capital intensive. To illustrate, Table 2 provides a cross sector comparison of wage shares in the Danish economy. The remaining share is almost all attributable to capital expenditures. Table 2 demonstrates that primary activities (agriculture and mining and quarrying) are the most capital intensive. In telecom and other network based utilities (electricity, gas and water) wage shares are at about 1/3 (and therefore capital shares at about 2/3), while all other industry groups are having substantial higher wage shares.

For an assessment of the cost structure's impact on market conditions, more than the level of investments in telecom is relevant. The type of investments is also important. A notable part of the investments are what economists refer to as "sunk costs". These are long term investments which can be used only for specific economic activities. An example is a fixed access network providing subscribers' access to the local exchange. This investment only has value for the supply of telecom services in this particular local area. Once the investment is made the operator can only exit this particular market at

considerable costs. Other investments have a shorter time horizon and/or can more easily be applied for other activities.

Investments in telecom networks divide into the following functional elements:

- Terminal equipment
- Access Network
- Switching
- Transmission/Long line
- Other (buildings etc.)

Industry	Wages as % of Contribution to GDP
Mining and Quarrying	8.9
Agriculture	23.5
Electricity, Gas and Water	29.7
Telecommunication	37.4
Market services (incl. Telecom.)	46.1
Manufacturing	67.1
Construction	78.3
Non Market Services	94.4
Total	62.8

Table 2 **– Wage shares by kind of activity**

Sources: Danish National Accounts Statistics 93, Danish Bureau of Statistics 1995 and calculations based on figures from Tele Denmark Annual Report 1994.

2.1 Terminal equipment

Once telephones were, for the vast majority of users, the only type of customer terminal connected to the network. These were all provided by the operator and rent was included in the access charge. It was part of a bundled service. Today a wide range of terminals are connected to the network in addition to telephones (faxes, PCs, PABXs etc.), and customers are now allowed to buy their own terminals, either from the network operator or from other suppliers. These terminals are owned by the customers and are not a part of the operator's fixed capital. This allows users to become more independent of the operator, but it also reduces the network operator's requirements for investments. Terminal equipment is now, in most countries, unbundled from the telecom network, and for many purposes is not considered part of it.

2.2 Access

The local access network connects the customers to the national and international networks. The most common form of access is a twisted pair of copper wires from the user's terminal to a local switch. Coaxial cables provide more bandwidth than twisted pairs and are most common in cable TV-networks. Optical fibres are used for certain broadband services, but are mainly used in the interexchange network, where its higher levels of capacity can be used more efficiently. Investments in cables are long term investments with a lifetime of more than 20 years. Moreover the investments are very

immobile. Once investments in the access network in a certain area are made, profit must be generated through communication services provided to customers located there. It is extremely difficult, if not impossible, to move investments to other maybe more attractive markets.

The access network is by far the most expensive part of the network. It covers between one-third and one-half of the investment costs. As access network assets have a relatively longer than average lifetime their significance on costs is even greater. The main cost components are cables and construction work related to the laying of cables.

2.3 Switching

The switching function is performed at the exchange by automatic, computer controlled equipment (or in older offices by electromechanical switches). Next to the access network, switching is the most expensive function. According to an Australian study, 90 percent of the switching costs are in local exchanges.[3] Major portions of the investments made in local exchanges, however, can be attributed to long distance communication or special services. The major part of the upgrading of the telecom network involves an upgrading of switching capability, especially with the conversion from analogue to digital technology.

2.4 Transmission/Long-line

This type of equipment includes cables, radio-links and satellites connecting transit exchanges, as well as transmitters, repeaters, etc. It provides the capacity to provide all kinds of long distance services. Although new technologies have reduced long distance transmission costs dramatically in recent years, they are not really as significant in the total cost picture as access and switching costs.

Detailed cost data that disaggregates network costs among the different parts of the network are quite difficult to obtain and compare. A recent OECD study of national PTOs in the OECD area analysed 1992 expenditures on switching and transmission infrastructure as a percentage of total capital expenditure. Although it showed large variations among PTOs, suggesting different accounting procedures, it revealed that together the PTOs mostly spend between 60 to 80 percent of their capital expenditure on switching and transmission infrastructure (OECD 1995, p.52). In most OECD countries, the major investments in the access networks were completed long before 1992.

The OECD study also notes that drawing a boundary between switching and transmission functions is becoming increasingly difficult because both are converging towards software based systems. Some experts suggest the software cost of developing a telecom exchange could be 80 percent of the total cost, and the software may be upgraded several times over the working life of the exchange.

Table 3 summarises the results of four comprehensive studies on network costs made in different countries covering different time periods. The first two studies from Germany and Japan are made as studies of investments over a longer time span; the Australian and Canadian studies are made for the purpose of costing services as a guideline for pricing and only provide detailed data for a one year cycle. The categorisation and definition of network components also differ from study to study and comparisons must therefore be made with caution. However all studies establish access and switching as the main cost elements. The reason for the variation between figures

from Bell Canada and from other operators arises primarily because certain local switching functions are included in the costs of the access network.

	Germany 62-71	Japan (NTT) 52-90	Australia 87-88	Bell Canada 1993
Terminal equipment	7	-	-	-
Access	40	35.5	34.5	50.1
Switching	30	29	25.0	13.9
Transmission/Long line	23	11	11.5	18.8
Other	-	24.5	29	22.2

Table 3 **– Network costs by network components (in %)**

Notes: Japan: The cost of underground facilities at 19%, have been allocated under access (14.5%) and under transmission/long line (4.5%).
Australia: Transmission includes long line equipment.
Canada: Calculated on basis of the average investment base. Long line includes all expenses attributed to long distance calls. Access includes terminal equipment.

Sources: Heuerman (1984). op.cit. Tadao Saito (1994): An Evolving Scenario of Communication Network Towards B-ISDN in V.B. Iversen (ed.): Integrated Broadband Communication Networks and Services, The cost of Telecom's Community Services Obligations, Bureau of Transport and Communications Economics Report 64, Canberra (1989), Fred G. Bigham (1993): A category Costing Approach to Support Telecommunications Service Pricing, East Lansing, Michigan.

3.0 Trends in Investment Costs

The most important factors of input to investments in telecom networks are electronic equipment, cables and wires. Prices for electronic equipment have decreased rapidly and are expected to continue declining in the future. This affects in particular the costs of switching but transmission is affected also.

Improved cable technology, and in particular the introduction of optical fibres, has reduced costs of cables substantially. Prices for copper wires are relatively stable, but new compression techniques are increasing its capacity. Optical fibre cable provides significantly greater capacity, and price reductions now make it competitive with copper cables for installation of new access networks on greenfield sites in some locations. However, at present it is not economical to replace installed copper cables. In the access network the laying of cable and wire constitute as much as 90 percent of the costs (Falch 1993). Thus the cost of the cable itself plays a diminishing role. But in the transmission network, where the increasing capacity of optical fibres can be utilised more advantageously, fibre cable will have a substantial impact. A forecast from Cambridge Strategic Management group estimates that by the year 2000 (Forge 1995) the costs of raw capacity of submarine cables will fall to just one percent of the costs in 1987.

Although investment goods are becoming cheaper, the level of investments in telecom services is growing rapidly and capital costs still constitute a substantial share of total costs of production. The historical development of the cost profile for telecom services can be illustrated by US cost data. The FCC has published cost data for US common carriers going back to 1950. Changes in accounting principles complicate comparisons for the years after 1987, but capital related operating expenses (depreciation

and amortisation) in 1994 were reported to be 24 percent of total operating expenses. Thus it can be seen from Table 4 that the proportion of capital related operating expenses has since the 1960s remained fairly constant. If the cost of capital and capital related taxes are added, total capital costs would at least be doubled, representing 40 to 60 percent of total annual economic costs.

On the other hand, dramatic decreases in traffic related expenditures, due to automation of switching functions and the beginning of the increase in commercial expenses as more resources are allocated to marketing and advertising can be seen in Table 4.

	Maintenance	Depreciation and Amortisation	Traffic	Commercial Exp.	General Office	Other	Total
1950	29	14	28	12	9	7	100
1960	29	22	19	14	10	7	100
1970	31	24	14	12	9	10	100
1980	32	21	8	15	10	14	100
1987	25	28	5	16	12	13	100

Table 4 **– US common carrier operating expenses (in %)**

Source: Calculated by data from Statistics of Communication Common Carriers (FCC 1995).

Technological improvements have changed the balance between services quite dramatically. A study made on the cost structure on a fibre-optical network indicates that bandwidth and distance will play a smaller role for costs in the future (Table 5). Further advances in compression techniques will add to this development. The reason for this is that with optical fibre the costs of cabling are almost independent of capacity needs.

	Costs in % of Total Costs
Access related costs	71
Distance related costs	13
Capacity related costs	16

Table 5 **– Distribution of costs in a fiber optic network**

Source: Stehman 1993 op.cit.

However, one important reservation has to be made to these figures. The distribution of costs is estimated on the basis of current services and does not take the network requirements of future services into account. The cost of services demanding more bandwidth are much more sensitive to distance than, for example, the costs of a telephone call. The reason for this is that the capacity of the access link is often under-utilised. A Japanese study by the Ministry of Post and Telecommunication on the investment costs of a B-ISDN network serving 50 million subscribers forecasts the costs of long lines equipment (which must be categorised as distance related costs) as 38 percent of the total (Table 6).

Items	Predicted Amount B USD	% of Total
Subscriber Line	126	41
Local Switches	63	21
Long Line Facilities	116	38
Total	305	100

Table 6 **– Forecasting of investments needed for a B-ISDN network with 50 mill. Subscribers**

Source: Tadao Saito (1994)

This indicates that demand for new types of services may have a substantial impact on the future cost-profile of network operators.

New services will also affect the cost profile in another way. In some services, the basic network provision itself will only be a minor part of the service delivered. Value added network services and intelligent services both add new activities and introduce new types of costs to network operators. Some of these costs such as development costs will be usage independent fixed costs, but they will not be regular sunk costs, which are tied to service provision in a specific geographical area.

There are other implications on the cost structure. Decreasing cost trends for equipment reduce the economic lifetime for installed network capacity. This implies that investments must be depreciated at a faster rate and profitability requirements must be raised. It also increases the barrier to exit as "old equipment" will have less value in alternative uses. Another important factor is the possibilities of substituting cables with satellite and cellular technologies. As these new networks compete with cable networks and become part of hybrid networks, the cost profile will continue to change.

4.0 Changing Demand Conditions

As a large proportion of the costs of telecom can be attributed to long term investments in the access-network, careful forecasting of network requirements is essential for cost effective provision of telecom services. In the OECD area, high growth rates in revenue in the mid-1980s have been followed by more moderate growth rates in the 1990s. A part of the explanation is decreasing tariffs as the decline in growth rates in the number of mainlines has been less pronounced (Table 7). Still, the slowdown indicates the market may be reaching saturation level in basic telephony services faster than new value-added services are stimulating new growth.

	CAGR 1982-87 (%)	CAGR 1987-92 (%)
Revenue	7.22	3.44
Mainlines	3.90	2.33

Table 7 **– Growth in public telecom in the OECD Area**

Source: OECD: Communications Outlook 1995.

Although many new services have been introduced and present impressive growth rates in number of subscribers, telephony is by far the most important service. In Table 8 the revenue for Tele Denmark by service is depicted. The most important of the new

services is mobile telephony. This service contributes 5-10 percent of the total revenue in most OECD countries.[4] Only in Sweden and Finland has the revenue exceeded 10 percent. However, with the present growth rates, mobile services can be expected to be more important in the future. Data-services and leased lines represent very small markets compared to telephony services. Therefore it is not surprising that patterns of demand have been studied most intensively for telephony service, and that a large number of econometric studies estimating key parameters have been prepared.[5] On the other hand, new services have been studied much less intensively and very little is known about patterns of demand for these services.

	1994
Domestic Telephony	40
International Telephony	16
Mobile Telephony	8
Leased Lines	5
Sale and Installation of Terminal Equipment	14
Phone Books	3
Datacommunication	2
Cable-TV	2
Others	10
Total	100

Table 8 **– Tele Denmark revenue by activity (in % of total)**

Source: Tele Denmark Annual Report 1994.

Demand for telephony has a very low sensitivity to changes in tariffs, but more expensive services such as long distance telephony tend to be more sensitive than local telephony, which is more of a necessity. Another characteristic for both telephony and many other communication services is the positive externalities created by the service. A completed telephone call requires the participation of a second party, which in most cases also is benefiting from the call (call externality). Another externality arises when a new subscriber is connected to the network. This will benefit all other subscribers which possibly could have a need to communicate with the new subscriber (access-externality). This point is very important for the introduction of new services. New services need to establish a critical mass of network subscribers before they really can become useful and the market can unfold.

Telecom services are offered to two distinct groups of customers with quite different patterns of demand, business and residential customers. The distribution between these two groups varies from country to country. In general the residential sector is most important in countries with a high penetration of telephones. Sweden, for example has near universal service with 78 percent of the lines connected to residential subscribers. For countries with underdeveloped telecom systems the vast majority of lines are connected to business users (ITU 1994).

If we examine the money spent on telecom, the business sector becomes much more significant in all countries. Although Denmark has near universal service with the great majority of lines supplied to residential customers, calculations based on Danish

national account data indicate that two thirds of the communication revenue originates from business customers.

Business demand is not equally distributed among the different sectors of the economy. Telecom is used most intensively in the services sector - especially trade and finance - and of course telecom services (Table 9).

Industry	
Telecommunications services	2.26
Wholesale and retail trade	1.50
Finance	1.21
Other Services	1.06
Transportation Services	0.83
Other Manufacturing	0.55
Paper and painting	0.53
Machinery	0.46
Construction and related	0.29
Metals	0.23
Broadcasting and utilities	0.20
Food and Tobacco	0.17
Agriculture and mining	0.16
Transportation equipment	0.14
Chemicals, plastics and related	0.14

Table 9 **– Average telecom expenditures as % of total costs (US, 1984-89).**

Source: F.J. Cronin et al: Relative demand for telecommunications. Information Economics and Policy Vol. 5. no. 1. Jan. 93.

An important point in relation to the need for regulation is that the demand profiles of these groups are quite different. A few decades ago all customers were demanding the same service – namely telephony. Business customers were generating more traffic but the service demand was basically the same. Today many business customers are demanding a wide range of communication services, which only a few residential customers consider to be relevant for them. On the other hand cable TV is only of limited use for business customers and other infotainment services primarily directed toward residential customers are being developed. Therefore, there is a growing segmentation between different user groups in terms of markets, services and interests. The main differences between these two markets are summarised in Table 10.

These differences result in different cost and market structures for the different customer groups. For the residential market the availability of an access network is particularly important. As the load of traffic per connection is relatively low, the needs

for capacity have been more stable in residential markets than business markets. Most residential customers have needed only an ordinary telephone line to meet their demands. Therefore, the need for investments to upgrade the network have been most apparent in business districts.

Residential Market	Business Customers
• Homogenous market	• Heterogeneous market
• Many small customers	• Both small and large customers
• 1-2 lines per customer	• Some customers with many lines
• Limited load of traffic per line	• More traffic per line
• Telephony and Cable-TV dominant services	• Demand for a wide range of services
• Limited use of advanced services	• Many customers with special needs

Table 10 **– Demand characteristics for residential and business customers**

Some business customers, especially larger firms and financial institutions, have in recent years demanded still more advanced services. These are the customers benefiting from the latest technological advances being implemented in the network. They may require new network facilities and tailor-made solutions developed by the incumbent network-operator or other service providers.

5.0 Conditions for Effective Competition

In economic theory, the notion of perfect competition is used to characterise an unregulated market where the forces of competition drive down prices to the level of production costs, and both price and production develop in such a way that the societal welfare is optimised. Such a market can be established if the following conditions are met: sufficiently large numbers of independent suppliers; sufficiently large numbers of independent consumers; free and easy entry and exit of suppliers; and full visibility of market conditions. It is not at all clear whether the telecom markets are likely to get close to meeting these conditions. If all these conditions are not fulfilled, the market cannot by itself optimise production. In this case it may become necessary to develop regulatory measures, which can “help” the market function more closely to the optimal condition.

In telecom the first condition is clearly the most problematic. It is obvious that this condition is not fulfilled today. In most areas - especially in the residential market - typically only one supplier is available. The major reason for this is that most countries have government regulatory restrictions, but in countries without such restrictions the market still has been dominated by only one supplier. This indicates that the characteristics of the market also have provided restrictions on the number of suppliers.

The point of departure in national telecom markets is one incumbent operator. In theory, other suppliers will arrive at the market as long as tariffs are high enough to permit them to do so profitably. This will result in competition and a downward pressure on tariffs. This process will take place until tariffs have reached a level where they reflect the efficient cost of production and no more suppliers are attracted.

However, it may be very difficult for new suppliers to enter the market. The most important barriers to entry which restrict the number of suppliers are:

- Economies of scale
- Economies of scope
- Economies of density
- Size and flexibility of investment

These factors affect both newcomers to the market and small companies that may already be present in the market. These factors do not play the same role in all network segments or in all market segments, as cost structures vary from segment to segment

5.1 Economies of Scale

Economies of scale reflects the opportunities for reduced unit costs with increased output. They provide efficiency advantages for large units of production and new entrants will find it difficult to compete with already well established firms with large scale production. If production of a certain service involves considerable economies of scale, new firms will find it difficult to compete with existing firms that have a well established large scale level of service supply. Furthermore smaller companies will tend to merge into larger units to remain competitive. Therefore, an unregulated market is likely to result in a very limited number of large scale suppliers.

There has been considerable disagreement on the extent of economies of scale in the telecom services industry. It has even been argued that operators above a certain size will experience decreasing returns of scale, partly due to increased administrative costs related to co-ordination of activities in a large organisation.[6] The data on network costs presented above indicate the presence of some economies of scale but do not by themselves demonstrate economies of scale significant enough to make competition unworkable. The major part of the costs can be attributed to the access network. Therefore, there is only a limited scope for pure techno-economic benefits related to a wider coverage going beyond the level of the local exchange, e.g. the establishment of a single national operator.

In a review of 20 cost-based studies based on figures from AT&T and Bell Canada almost all studies indicate some degree of economies of scale.[7] However, such studies do not take into account that the analysed cost structures have evolved under a regulated monopoly. Large operators will tend to invest in technologies where technologies of scale apply. Thus it is not correct to presume that the cost structure that has emerged under one market structure would have emerged under an alternative market structure (Wenders 1992).

If economies of scale are significant, one might expect it to be exhibited by increased productivity in large scale operators. In Figure 1 the results of one measure for productivity of PTOs in OECD countries are present ed., i.e., mainlines per employee. In order to illustrate the possible implications of scale the national operators are ranked by size (smallest to largest). Although a very slight trend towards higher productivity with increasing size is illustrated, there are notable exceptions (Turkey and Luxembourg especially). The data is consistent with the hypothesis of scale economies, but it does not prove the case as the productivity data is influenced by other factors as well, and once

again the scale of the economies indicated are not sufficient to make competition unworkable.

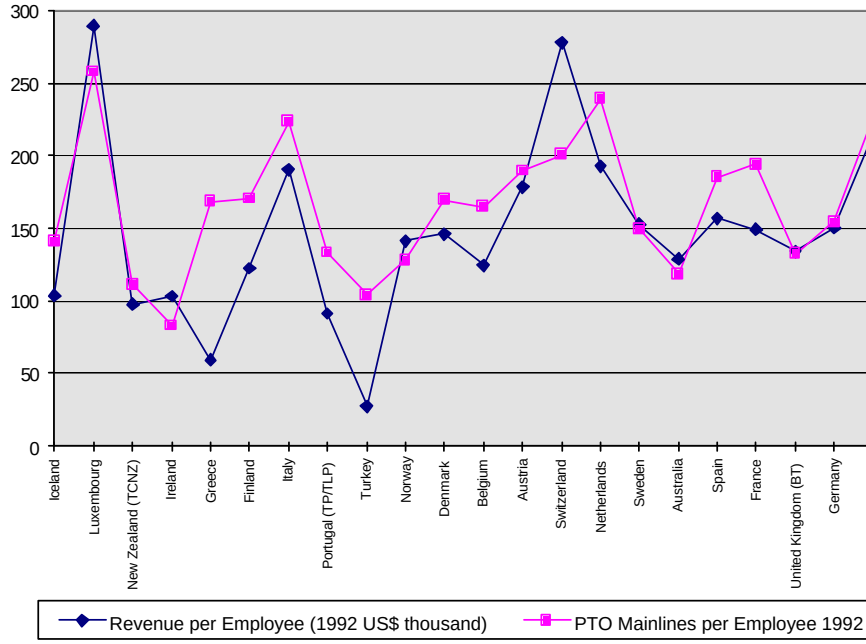

Figure 1 **– Productivity indicators for PTOs**

Source: OECD Communications Outlook 1995, p. 56, 57, 96, 100, 102.

In addition, although the presented evidence indicates a degree of economies of scale for delivery of telecom services as such, economies of scale do not necessarily apply for all parts of the service. If the various service components are produced separately, there will be areas where economies of scale are even less pronounced. For example, when the telecom handset and other terminals were separated from the network, a terminal market was created where scale effects are less significant and small independent suppliers can compete with the large operators in the supply of many kinds of terminals. In many countries the PTOs have lost most of the terminal market to competitors. Nevertheless for network services economies of scale remains a significant but not controlling factor.

5.2 Economies of Scope

Economies of scope are defined as cost savings related to supplying a number of different services by the same company. Economies of scope can be a barrier against smaller companies only supplying a limited range of services. This could be a local operator or an international carrier. Three different types of economies of scope can be distinguished:

- economies of horizontal integration
  (e.g. telephony and data);

- economies of vertical integration within the network;
  (e.g. local and long distance); voice and value added network services (e.g. call forwarding); and,

- economies of vertical integration beyond the network
  (e.g. information production and distribution).

Traditionally, the incumbent operators have produced all telecom services themselves. However, digitalisation has improved the technical possibilities for vertical separation of different service elements. In addition, decreasing costs of transmission give more flexibility for the location of value added services such as voice-mail and other intelligent network services. Digitalisation also improves integration of transmission of different services in the same network. However, the extent of economies of scope related to provision of narrowband telecom and CATV services are still under debate (Stolleman 1993).

Economies of scope can also arise in billing and customer relations. Operators supplying a full range of services can offer their customers one stop shopping and one stop billing. This gives an advantage compared to service providers specialising in a few areas. It is a factor influencing global alliances in telecom to meet the demands of global transnational corporations.

5.3 Economies of Density

Economies of density is related to the fact that network costs per connection decreases with increasing density of connections. The primary reason for this is shorter access lines and better capacity utilisation of the network. Economies of density implies that it is very difficult for newcomers in an area to compete with a former monopolist, where local networks with a high penetration already have been established. This is of course particularly important in the residential market, where the revenue per customer is much lower than in the business sector.

A newcomer may either build its own infrastructure from scratch or buy parts of its capacity from the incumbent operator. In some instances a duplicate network infrastructure can be built on top of other types of infrastructures e.g. local cable-TV or electric power networks. But even in these cases considerable investments must be made before sufficient economies of density in supplying interactive network services can be achieved.

From a regulators point of view the barrier created through economies of density can be overcome either by supporting the building of alternative infrastructures - e.g. right of way access, tariff regulations, taxation of the incumbent operator or other approaches. Or regulatory measures can be enforced in order to ensure competitors fair access to existing network facilities. The first solution may promote short run competition most directly. But if there are significant economies of density it may be a costly solution as it implies a substantial duplication of network investments. Furthermore it is probable that this competition will be eliminated in the long run as the competitors are driven toward more efficient arrangements for meeting consumer demands.

6.0 Size and Flexibility of Investment

The barriers of entry and exit in telecom are related both to size and lack of flexibility in investment in facilities. The large amounts of investment and the demand for technical capability makes the market for telecom infrastructure development quite exclusive. Companies in this sector must command considerable financial strength. But more important is the lack of flexibility in investments already made. A fixed network cannot be moved and can only serve communication between certain specific locations. Manufacturing industries can sell their products at different markets without major changes in production equipment. However in telecom this is not possible. Investments in telecom assets are for a large part called sunk costs – investments in relatively long-lived assets ear-marked for a specific activity. Once the investment is made it will be very difficult to leave the market without major losses.

7.0 Demand-related Factors

Demand for telecom services evolves from a core demand for a homogenous output – basic telephony – for which pure transmission is the common ingredient in a wide range of services, where transmission often is combined with other service functions. Increasingly these services are offered by service providers other than the provider of the basic transmission services, usually the incumbent PTO. Other producers may be foreign telecom operators, computer companies or companies from another industry.

Cost structures differ for different services, and market structure depends a great deal on the type of service demanded. Cable based transmission intensive services with a low level of processing involve relatively higher sunk costs than processing intensive services, where substantial value is added to the basic transmission.

So far, increased demand for new services has tended to change the overall cost-structure in the direction of a reduced share of costs for transmission and an increasing share on processing and value added components. This implies a decreasing role of sunk costs and better conditions for stimulating competition at least in the value-added segment. Advanced services provided for large business customers are less dependent on services from the network operator. If special facilities are needed, special network solutions can be designed on a network of leased lines.

This development may not be feasible for services designed for residential customers. Advanced residential services must rely on transmission facilities as defined by the local network operator. As the existing cost structure implies that basic residential services is the area where there are the greatest barriers to developing effective competition, diffusion of such services may be restricted to a pace determined by the local PTO.

Positive externalities related to usage and access imply that consumers depend not only on the network operator but also on the behaviour of other consumers. Call and access externalities give telecom services the character of a public good. Therefore, a free market may result in production and usage of services below the social optimum. This problem is partly addressed for basic telephony by imposing on the operators a universal service obligation, but the problem may be more acute in relation to new services where obtaining a critical mass large enough to make the service attractive can cause difficulties. This barrier can be overcome by public initiatives, such as the generation of

public demand and standardisation. However, it may be difficult beforehand to foresee which services deserve public support.

8.0 The Role of Technological Innovation

Technical innovations have contributed to a reduction of barriers to competition in several ways:

- *Changing structures of network costs:* Reductions in transmission costs limit investments needed for delivery of the same services. In particular the unit costs of the interexchange network capacity are being reduced continuously.

- *Development of broadband services* is closely related to reductions in costs of transmission. However, substantial demand for broadband services will multiply the demand for transmission capacity, and the costs of both the access and interexchange network will increase as a result of this major network upgrade.

- *Lifetime of equipment is reduced:* With rapid technological innovations old equipment becomes obsolete more quickly. This increases capital costs (a faster rate of depreciation is needed), shortens the planning horizon and increases the risk.

- *Digitalisation* increases economies of scope for provision of facilities, but reduces economies of scope for service provision. If effective interconnection rules are established, digitalisation improves the conditions for service providers without their own physical infrastructure.

- *Satellite and cellular services* can provide alternatives for some local exchange network services. The cost structure of air-borne services involve fewer economies of density than wired services. Therefore a degree of infrastructure competition can be introduced at lower costs. Although satellite and cellular services cannot be complete substitutes for wired based services they do reduce the monopoly power of local exchange operators somewhat, and provide an alternative for some business and residential services and customers although far less than a majority.

9.0 Conclusion

A few decades ago the market for telecom services was a homogenous market supplying essentially the same service – telephony – to all types of customers. Today the market is becoming much more diversified with an increasing range of services offered by incumbent PTOs, providers of cable-television, data communication companies etc. Most of these new companies have not invested in their own physical infrastructure but rely on network capacity leased from other operators.

This paper has presented an overview of cost and demand factors and their implications for creating a competitive market for telecom services. The most significant barriers to competition are related to the cable and wire-based local facilities network. It seems unlikely that effective competition in this area can be established. In other areas, barriers to entry are less dominant and competition can more easily be established. Long distance and cellular telephony are both areas where competition can more easily be

established, and where competition has been successfully introduced in some countries although the number of suppliers has been limited. In the market for many types of value added services, opportunities for effective competition are greatest, assuming reasonable access to PTO networks. The task of telecom regulators is to separate services where effective competition can be established from services where regulation is needed to protect customer interests.

Most services depend on interconnection with the wired network. Therefore, regulation of the terms for interconnection are crucial for the development of effective competition in areas where barriers related to cost and demand structures can be overcome. As some providers are able to rely on their own infrastructure, while others rely on leased lines, full information transparency in this market is essential if competition on equal terms is to be created.

The evidence indicates that the market for wired residential services will need to be monitored closely by regulators, as this market segment has a cost structure making it very difficult to develop effective competition. Operators providing services both where effective competition can be established and in areas where competition is more difficult to establish will be tempted to cross-subsidise their most competitive services at the expense of their monopoly services as a way of strengthening their market position. Therefore, tariffs for local wire-based services, and in particular services offered to residential customers will need close monitoring. This can only be done if detailed cost data are made available by the dominant PTO. The operator must be able to calculate service costs for each service to ensure that tariffs can be justified, cross-subsidisation is not taking place and the operator's services are being provided efficiently and profitably. In this manner, strong regulation can ensure proper attention to real costs and maximum scope for competition.

Endnotes

[1] A number of statistical analyses have been made to establish a relationship between innovativeness and the level of competition but results so far are very ambiguous, (e.g. see Larry R. Blank a.o. (1994), J. v. Cuilenberg & P. Slaa (1995) and S. Stanislawski (1993).

[2] K.H. Heuerman (1984), Gebührenpolitik im Telekommunikationsbereich, Baden-Baden. Quoted from Oliver Stehman (1995): Network Competition for European Telecommunications. Oxford University Press.

[3] The Cost of Telecom's Community Services Obligations, (1989), Bureau of Transport and Communications Economics Report 64, Canberra.

[4] OECD: Communications Outlook 1995 (1992 figures).

[5] See e.g. L. D. Taylor (1984) for an overview.

[6] Eli Noam has argued that networks beyond a certain size become inefficient and used this argument as a reason to break up the existing monopolies (E. Noam, 1992).

[7] Ole Jess Olsen (1993) chapter 6.1. See also Alfred E. Kahn (1988) chapter vol. II chapter 4.