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Forming the Productivity Commission

The Industry Commission, the former Bureau of Industry Economics and the Economic Planning Advisory Commission have amalgamated on an administrative basis to prepare for the formation of the Productivity Commission. Legislation formally establishing the new Commission is before Parliament.

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ABBREVIATIONS

ACCC	Australian Competition and Consumer Commission
AGT	Alberta Government Telephones
AMPS	Advanced Mobile Phone System
ANZCAN	Australia, New Zealand, Canada Undersea Cable
AOTC	Australian and Overseas Telecommunications Corporation
APO	Australian Post Office
AUSSAT	Australian domestic communications satellite system
AUSTEL	Australian Telecommunications Authority
bps	bits per second
BT	British Telecom
BTCE	Bureau of Transport and Communications Economics
CAM	cost allocation manual
CAN	customer access network
CAP	competitive access providers
COA	chart of accounts
CPE	customer premises equipment
CPI	consumer price index
CSO	community service obligations
DAIC	directly attributable incremental cost
ECPR	efficient component pricing rule
FCC	Federal Communications Commission
FDM	frequency division multiplexer
GDP	gross domestic product
GSM	Global System for Mobiles
HES	household expenditure survey

IDD	international direct call
ISD	international subscriber dialling
ISDN	integrated services digital network
ITU	International Telecommunications Union
LAN	local area network
LATA	local access transport areas
LEN	local exchange network
N&D	Notification and Disallowance
OECD	Organisation of Economic Co-operation and Development
OTC	Overseas Telecommunications Commission/Corporation
PABX	private automatic branch exchange
PCN	personal communications network
PSA	Prices Surveillance Authority
PSTN	public switched telephone network
ROSA	Review of Ownership and Structural Arrangements
SP	service provider
SPC	stored program control
STD	subscriber trunk dialling
SUR	seemingly unrelated regression
TDM	time division multiplexer
TFP	total factor productivity
USO	universal service obligations
VAN	value-added network
VANS	value-added network services
VAS	value-added services
WAN	wide area network

SUMMARY

The Australian telecommunications service industry is in a process of transition — from a statutory monopoly that is fully government owned and operated, to an industry with greater competition and higher private sector participation. The end point of this process is not clear — it will depend on the evolution of technology (and hence costs), customer preferences and the regulatory structure.

While there is considerable uncertainty about where the transition will lead, this study seeks to deepen understanding of where the industry is at the moment, and what might be required of the policy environment over the next ten years or so.

Technology and costs

In the past, telecommunications was among a group of infrastructure industries thought to need protection from competition. In particular, the high fixed costs of building a local network were thought to make the industry a natural monopoly. As a result, duplication by a new entrant was considered ‘wasteful’.

Technology

Telecommunications technology has changed remarkably (Chapter 1). The speed and capacity of the transmission and switching equipment used in telecommunications networks has increased over time. This has lowered considerably the costs of providing a given level of network capacity.

There has also been increasing variety. Transmission can now be by a number of media including coaxial cable, fibre optic cable, microwave or satellite. In addition to switching used for the public switched telephone network, there is PABX, packet switching and ISDN switching.

New technology has facilitated the developments of new services such as facsimiles, data, video images, cable TV and multimedia that now complement traditional voice messages. This has also allowed other networks to develop, both interconnected to the public switched telephone network and sometimes in competition with it, including cellular mobile networks, paging networks, data networks, and local, regional and wide area networks.

Costs

In light of these developments, it is important to review recent empirical evidence, which mainly relates to overseas telecommunications networks, on whether the local network is a natural monopoly (Chapter 2).

Unfortunately, even the more recent empirical studies of economies of scale and scope are not conclusive, primarily because they rely on limited data from large incumbent telecommunications carriers. Therefore, the studies provide little information of relevance to Australian circumstances, other than to demonstrate that no definitive empirical evidence exists to prove or disprove the popular contention that the local network has cost characteristics conducive to a natural monopoly.

Even if the incumbents did have such cost characteristics, this would not necessarily imply that competition or duplication of certain infrastructure was undesirable (Chapters 2 and 7). These cost characteristics would imply a natural monopoly only if new entrants had (or perhaps were constrained to use) the same technology as the incumbent. If, however, it were possible for a new entrant to provide comparable services using lower-cost technology, its entry (and the incumbent's potential demise) could be a socially desirable outcome.

A natural monopoly also presupposes that market coordination between separate firms (say by networking, pooling or interconnecting) is unable to achieve the same economies as internal coordination within a single firm. With the increasing unbundling and interconnection of telecommunications services, it is not clear that this presupposition holds.

Thus, it is unclear whether the cost structures of dominant carriers preclude competition, even in the local network. But the large proportion of costs that are 'fixed' (not traffic-sensitive) does pose a dilemma for the pricing of final services. The dilemma is that, while economic efficiency would be best served by pricing individual services to cover the additional (ie variable) network costs that each additional service imposes, such incremental costs can be very small and a firm that priced in this fashion would not cover its total costs.

Efficient pricing of final services

An understanding of the price responsiveness (elasticity) of business and residential demand for various telecommunications services is an important prerequisite for assessing the efficiency of alternative pricing structures for final services (Chapter 3).

Elasticity estimates

The demand for customer *access* is generally found to be very unresponsive (*inelastic*) to variations in its own price, both for business and residential customers, but especially for business. There is an obvious relationship, however, between the demand for customer access and the prices charged for different types of telephone call. Studies have shown that, holding constant other prices and income, a reduction in service prices leads to increased demand for customer access.

The demand for *services* is more price responsive (*elastic*) the longer the distance of the call. Thus, demand for long-distance calls is much more elastic than for local calls. International calls are more elastic again, with the number of call minutes increasing more than proportionately for a given reduction in price. However, demand for any given service is less elastic for business users than for residential ones. Demands are also less elastic in the peak periods.

Efficient pricing structures

The two dominant approaches to efficient public utility pricing are two-part pricing and Ramsey-Boiteux pricing (Chapter 4). As traffic-sensitive costs are very low relative to 'fixed' costs, a two-part pricing approach to telecommunications services would result in extremely low use prices (except perhaps at peak load) and very high access charges. On the other hand, application of the Ramsey-Boiteux principle would result in very high prices for use.

An intermediate solution between these extremes is both defensible in principle and pragmatic in the face of existing pricing structures. This approach involves recognising three levels of costs:

- specific operating costs that vary in the short run with the level of services;
- costs which are fixed in the short run but can be attributed to a particular function (eg long-distance carriage); and
- unallocable overheads — 'head office costs' — which cannot be attributed to any particular service.

A proposed solution is that subscriber access charges would meet the full costs of providing access, and provide some contribution to unallocable overheads. Pricing for use of the various networks — principally the local exchange network, the long-distance network and various value-added networks (including mobile) — would be based on long-run marginal costs, defined as the average costs of preserving the network's capacity in the long run. Any deviations of access or use prices from long-run marginal costs necessary to meet unallocable costs would follow the Ramsey-Boiteux principle.

Efficiency gains in an ideal world

Existing pricing structures in Australia — the product of a variety of factors relating to costs and technology, user demands, competition and political decisions — differ considerably from this benchmark.

- Subscriber access prices are below levels consistent with cost recovery — the subsidy cannot be justified by network externalities in a mature network with a very high penetration rate.
- Prices for use of different services exceed long-run marginal cost, but the deviations do not reflect the price responsiveness of demand, as required under the Ramsey-Boiteux principle.
- Peak load pricing principles are not employed in pricing of the local exchange network, although the importance of this has declined as technological change has progressively reduced the cost of meeting peak demands.

Significant changes to present pricing practices would be required to address the first two problems outlined above. The changes would nevertheless generate substantial efficiency gains — in the order of $400 million and $60 million, respectively, from Telstra and Optus adopting a more efficient pricing regime (Chapter 8). In practice, such changes are unlikely to be adopted, partly because of regulatory constraints and partly because of the magnitudes involved. While use charges would fall significantly, access charges would have to rise, particularly for business users.

Efficiency gains in a constrained world

It is more realistic to assume that the increases in access charges are likely to be constrained. The sub-cap on Telstra's residential access charges would prevent any increase in those charges for residential users, while the increase in business access charges may also be constrained for practical reasons. However, the present AUSTEL sub-caps on Telstra's telephone call charges would preclude increases in the price of local calls as an alternative way of covering costs. Thus, some increase in business access charges would still be required, allowing modest reductions in the prices of long-distance and international calls.

In this more constrained environment, efficiency gains are still available — the gains from Telstra adopting this price structure are estimated at $140 million a year. The difference between this and Telstra's first scenario is a forgone efficiency gain of $260 million, about $160 million of which is attributable to the AUSTEL price sub-cap on Telstra's residential access charge.

Thus, the cost (in terms of forgone efficiency gain) of the residential access price sub-cap is substantial. Nevertheless, were the sub-cap removed, an increase in the price of residential access to cover its long-run marginal cost may make some households worse off, particularly those whose expenditure on access and local calls makes up a large proportion of their total expenditure on telecommunications services. Such an increase in the access charge may even result in some households discontinuing access.

There is a range of options for funding a compensation scheme for vulnerable households. A decrease in total Telstra costs of just 1.2 per cent would fund one such scheme. Telstra could apparently achieve much greater cost reductions than this. Telstra has indicated that it would need to reduce costs by 26 per cent to be ‘where it ought to be’. In addition to freeing up more than enough revenue to fund compensation for increased residential access charges, a cost reduction of 26 per cent would generate substantial additional efficiency gains.

Competition and efficient access pricing

Australia is by no means the only country to have introduced competition into the provision of basic telecommunications services. Typically, the objective has been to achieve efficiency gains in the form of more efficient pricing, greater technical efficiency and dynamic efficiencies.

As a rule, the new entrant has not been expected to establish its own complete network, but has been granted regulated access to the incumbent’s network, particularly for the reticulation of its local calls.

Access pricing principles

In introducing competition, the principles governing the setting of the access price to all, or part of the system are crucial (Chapter 5). An excessively high price may deter socially-desirable entry of users, or alternatively encourage wasteful duplication. A price too low could deter efficient entry of providers and lead to insolvency of the incumbent.

The principles of access pricing have been the subject of intense debate. Suggested bases have ranged from some concept of the access provider’s long-run marginal cost of providing access to the local exchange network, to Baumol and Willig’s efficient component pricing rule. The former is a lower bound to the price that might be charged, and was loosely the basis on which Optus was granted access to the local network in 1992. The latter is the upper bound, including long-run marginal cost but also taking into account the incumbent’s opportunity costs of lost contribution to overheads and profits in downstream markets.

The objectives of introducing competition have not always been central in the discussion of access pricing. This is particularly true of the efficient component pricing rule, where its proponents have taken a narrow view of ‘efficiency’.

Network competition

At the time Optus decided to set up its own local network, the price of access to Telstra’s network was apparently above the resource cost of that network (Chapter 7). Thus, Optus’s rollout did not need to provide a comparable service to Telstra’s at lower resource cost, in order to be worthwhile from Optus’s perspective. It would have been in Optus’s interests to proceed as long as its costs were lower than those determined by the access charges to the Telstra network. However, in these circumstances, Optus’s rollout may not have been in the national interest, in the sense of lowering the resource cost of pay-TV/local telecommunications services.

But even if duplication has pushed up the real resource cost of providing telephone services, it also has the potential to benefit consumers. There is some evidence that, even in the current duopoly situation, the increased competition has put downward pressure on the ‘wholesale’ price of access to Telstra’s local network. There is also clear evidence that Optus’s rollout has encouraged Telstra to upgrade the quality of its network earlier than it otherwise would.

To a large extent, judgments about whether the current network duplication is socially wasteful hinge on the perceived balance between the prospect that duplication raises resource costs, relative to the prospect that competition reduces monopoly prices and generates benefits for consumers. A case for regulating to prevent entry could be made only when this balance is negative, and when there there are significant ‘sunk’ costs that cannot be recouped in the event that an entrant leaves the industry. The legislative changes to take effect from 1 July 1997, among other things, will create an environment which reduces the extent to which telecommunications costs are sunk.

New access arrangements

The Australian telecommunications industry will be further opened to competition from 1 July 1997 when the existing duopoly ends. The new Exposure Draft on the post-July legislation is the latest in a series of reforms over the past two decades (Chapter 6). The arbitrator on access disputes when commercial negotiation fails will become the Australian Competition and Consumer Commission (ACCC) rather than AUSTEL. There are proposed additions to the Trade Practices Act which will continue specific competition rules for telecommunications, aiming to allow the ACCC to act more quickly against anti-competitive conduct. Meanwhile, existing price capping regulation will be administered by the Australian Communications Authority, formed when parts of AUSTEL merge with the Spectrum Management Agency.

Under existing arrangements, Optus has been able to gain about 15 per cent of the long-distance market and around 23 per cent of the international call market. Optus and Telstra have apparently not engaged in aggressive price competition in these markets as there are still large gaps between prices and costs. The new access regime should not do anything to help hold up long-distance and international call prices. But nor should it undermine the financial viability of the existing carriers. A rate of about 2.5 cents per minute for network access would satisfy these twin objectives (Chapter 9). Inclusion of CAN costs, overhead costs or USO/CSO contributions into the access pricing formula would distract attention from more efficient ways of recovering those costs and merely perpetuate current inefficiencies.

Institutional structure for competition

Three possible areas of inefficiency have been considered with respect to the existing arrangements for Telstra providing access to its rivals as well as to itself (Chapter 10). These are anti-competitive conduct, inefficient and inconsistent use of the local exchange network, and retail product market collusion.

AUSTEL's so-called 'accounting separation' — involving confidential product-based financial statements through the Chart of Accounts (COA) and Cost Allocation Manual (CAM) — assists marginally with respect to the first and second of these, by providing information which may help in the identification of anti-competitive behaviour and in guiding the determination of interconnect access prices. However, this division is strictly for regulatory purposes, and does not reflect any other use of the accounts within Telstra.

Formation of arms-length business divisions of Telstra with clear commercial objectives would be a sounder basis for the further liberalisation of Australian telecommunications. One of these would supply access and local switching on a commercial basis to other parts of Telstra and to other carriers and service providers. This would have marginal benefits with respect to all three problem areas with the existing environment.

US-style divestiture, where the local exchange network was separated off under independent ownership, would be a superior approach to all three problems. Divestiture could present difficulties with respect to so-called double marginalisation (where the downstream firm applies a profit margin on costs that are already inflated with a profit margin of the upstream firm) and the possible sacrifice of economies of scope. There is no strong evidence that either of these problems is likely. However, this option may have been partially closed off by the passage of legislation that will lead to the sale of one-third of Telstra.

1 SUPPLY OF TELECOMMUNICATIONS SERVICES

This chapter describes the infrastructure and facilities used to provide telecommunications services in Australia. The different types of telecommunications networks in Australia are discussed and the operation of their individual components are examined. The chapter focuses on the major components of the domestic and international networks, which are transmission facilities and switching equipment. In addition, customer premises equipment, which allows users to access the network, is also described.

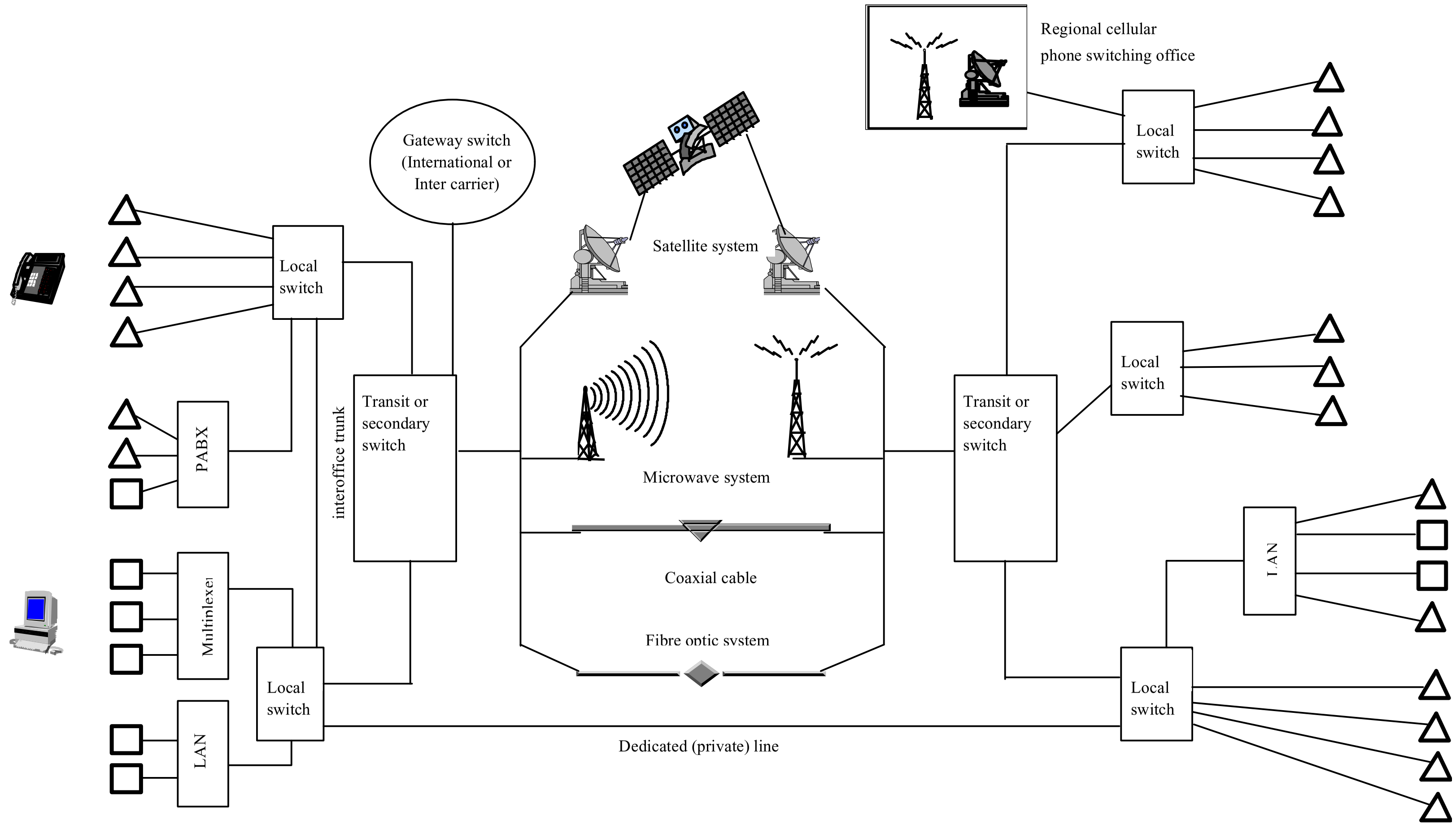
1.1 Telecommunications networks

Telecommunications services were first provided in Australia in 1854 when a telegraph line was opened in Melbourne. The first Australian telephone service, which was limited to a local area, became operational in 1880. The subsequent expansion of the telephone network enabled customers to make local, trunk (domestic long-distance) and international calls.

Telecommunications networks now provide a variety of additional voice services including call diversion and voice conferencing. The networks also carry data, video (a combination of voice and data) and image (a sequential series of still pictures). In addition, they support a variety of enhanced and specialised services including electronic funds transfer, electronic messaging and information services. In 1994 it was estimated that a total of 462 different types of telecommunications services were available in Australia (Budde 1994). The range of services provided over telecommunications networks is likely to increase further with technological change and the convergence of the telecommunications, broadcasting, computing and entertainment industries.

There are many telecommunications networks in operation, and they provide a variety of services. Figure 1.1 depicts a typical national telecommunications network. These networks can often be very complex and may employ a variety of technologies.

Figure 1.1: **A typical telecommunications network**



Networks can be categorised into two main groups depending on the availability of their use: public switched telephone networks (PSTN) and private networks. Public switched telephone networks can be used by everyone while private networks are usually restricted to one organisation or a group of organisations. Networks can also be categorised on the basis of the physical distance between devices on the network and the communications and services provided by the network: local area, regional, wide area and international (Stair 1996).

Private networks

Private or leased facilities are dedicated to the exclusive use of one subscriber. The line or network of lines is always available for the customer's use. The subscriber pays a fee for the service, and is entitled to use the lines on an unlimited basis. The fee paid for leasing the lines is obviously dependent on the service provided. Permanently connected private lines have several advantages. The line, or network of lines, is always available and can be specially treated to reduce distortion and improve transmission quality. Private facilities range from point-to-point telephone lines to nationwide switched voice and data systems.

Public switched telephone networks

The traditional PSTN was originally developed to service voice traffic. Today data can also be carried by the same network using a modem (described later) at each end of the link. The PSTN provides the basic infrastructure for telecommunications services in Australia. Other networks that interconnect with the PSTN and utilise this infrastructure to varying degrees include cellular mobile networks, paging networks, data networks, the Integrated Services Digital Network (ISDN) and the international network. In Australia, the PSTN has traditionally operated through a hierarchy of switches and associated transmission links. However, with the modernisation of equipment and systems, the basic network in Australia is currently evolving to a structure of fewer levels and a less hierarchical structure (BTCE 1995).

The system of switches and the links between them determine the call routing strategies for individual calls. The first connection is between the caller and the local switch, with these connections being known collectively as the customer access network (CAN). In the first instance, the connection to the local switch allows the caller to make calls to other customers who are directly connected to the same switch. If the direct route between two local switches in unavailable due to other traffic, the call may be rerouted through one or more transit switches. For long-distance services, calls are passed to the called party's local switch through one or more transit switches and along the connecting transmission facilities. The transit switches are linked to international gateway switches which provide access to networks in other countries.

In Australia, both Telstra and Optus own and operate switches and transmission facilities which has resulted in two public switched telephone networks. However, these networks are not identical, either in terms of technology employed, geographical coverage or services offered. Therefore, interconnection arrangements exist which allow calls to be passed between the two networks.

Local area networks

A local area network (LAN) describes a configuration of telecommunications facilities used to communicate within a limited geographic area. LANs are designed to operate as high-speed, low-cost data systems over a limited distance, usually linking terminals, PCs and servers in a building or group of buildings in close proximity. While data transmission is the major application, some LANs also carry voice and video, particularly analogue-based broadband LANs (Minoli 1991).

Regional and wide area networks

Telecommunications systems that tie together regional and local areas are typical regional networks. A cellular mobile phone system is an example of a regional network. Wide area networks (WANs) tie together large geographic regions using microwave, satellite transmission or telephone lines. Long-distance calls use a WAN. Companies also design and implement WANs for private use. These WANs usually consist of computer equipment owned by the user, together with data communications equipment provided by a common carrier.

Value added carriers often control one of the most common types of WAN, called a value-added network (VAN). A VAN is a network with services in addition to those offered by a traditional network. A value-added carrier may lease the communication lines from a public company and then enhance standard services by attaching special devices such as modems and multiplexers (discussed later), and by providing computer services and access to databases. The primary feature that distinguishes a VAN from a WAN is that VANs not only transmit information, they change or enhance it. The additional services may provide more effective, faster and more economical communications.

International network

The international network is primarily a system of country to country telecommunications links which are jointly operated by the international carriers of both countries. An international call requires the connection of the domestic network of the country where the call originates, through an international gateway exchange, to an international line carried by cable or satellite and, through another international exchange, to the domestic network where the call is terminating. Australian carriers operate a half circuit from Australia's international gateway switch to the mid-point of the international circuit, while its foreign counterparts operate the other half of the circuit (BTCE 1993).

The international telecommunications links are provided either by satellites, operated by international organisations such as INTELSAT or Inmarsat, or cable. INTELSAT and Inmarsat are inter-governmental organisations established by treaty. The purpose of these organisations is to provide satellite capacity for international public telecommunications services to over 180 countries. Through INTELSAT, Australia has direct access to the world via antenna systems that operate to INTELSAT satellites over the Pacific and Indian Oceans for switched and private services. Some 60 per cent of Australia's international public switched traffic is carried by INTELSAT (BTCE 1993). Through Inmarsat, Australia has direct access to Inmarsat's Pacific and Indian Ocean region satellites via antennae that enable provision of land mobile, maritime and aeronautical services.

In addition to satellite systems, cable systems also link Australia's telecommunications network to the rest of the world. The first transatlantic telephone cable commenced operation in 1956, with the first Pacific telephone cable laid in 1962. The first Pacific cable system had only 82 circuits, and was superseded by the initial Australia, New Zealand, Canada Undersea Cable (ANZCAN), which had the equivalent of some 1 400 voice circuits (BTCE 1993). Telstra owns almost all of the half circuit cable terminating in Australia and is also a major shareholder in a number of cable systems located in different parts of the world. Both Telstra and Optus have plans to increase investments in undersea optical fibre cables. Optical fibre technology, which has led to an increase in the traffic capacity of cable networks, is now being used in many cable projects worldwide including Tasman 2 between Sydney and Auckland, PacRim East and PacRim West which carry traffic across the Pacific Ocean.

1.2 Customer premises equipment

The means of accessing the telecommunications network for consumers is through customer premises equipment (CPE). This equipment includes telephone handsets, facsimile machines, answering machines, private automatic branch exchanges (PABX) and ISDN terminals.

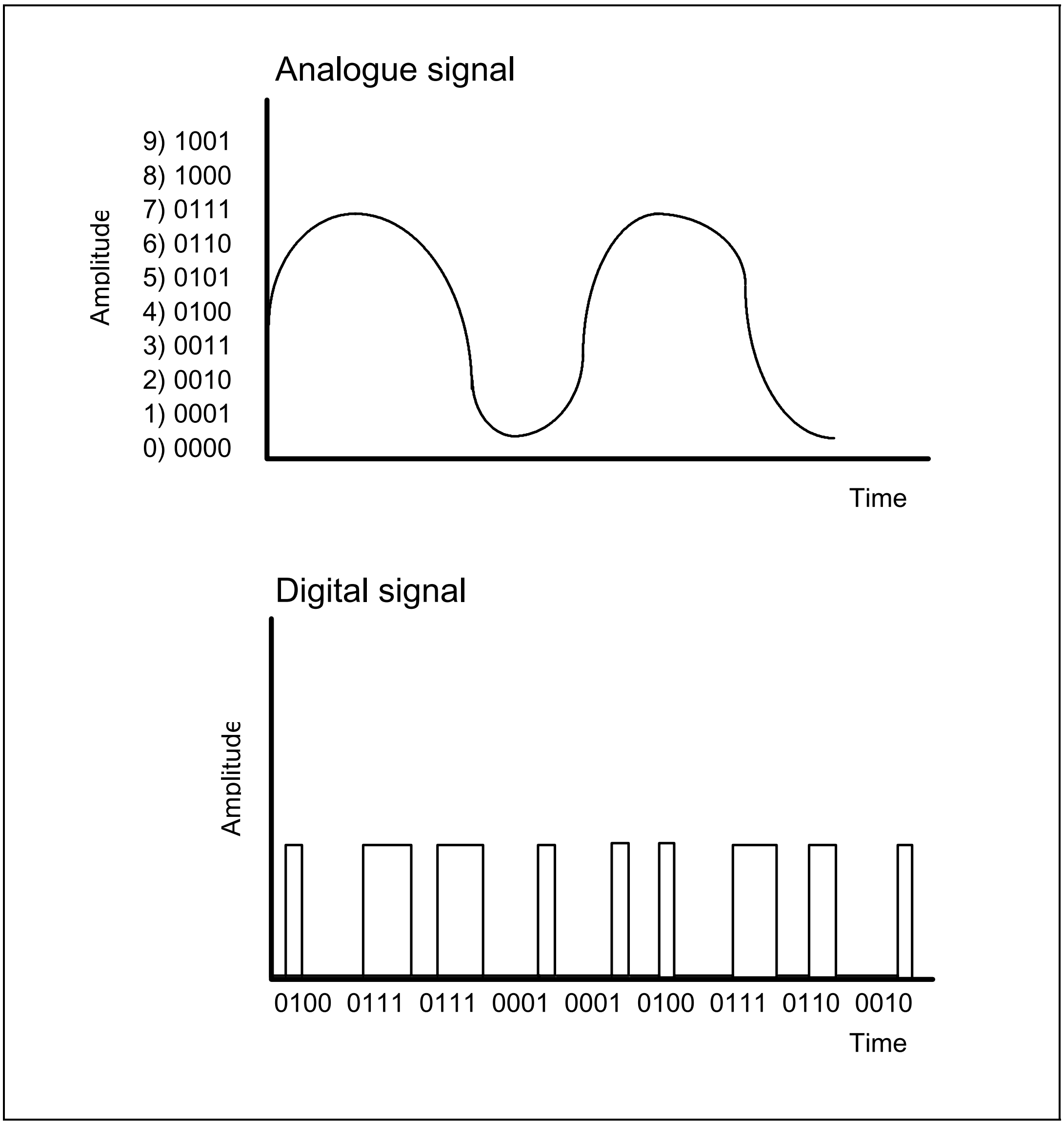
Lines known as intra-premises wiring connect all CPE items within a customer’s premises (BTCE 1995). This wiring is brought together at a central point from where there is a connection to the carrier’s network.

The dedicated line between the customer’s premises and the local switch is called the local loop. These lines are collectively known as the CAN. In Australia, the CAN generally consists of shielded or unshielded twisted copper pair wires, although there are some optical fibre cable, coaxial cable and radio connections (these transmission mediums are described in detail in the next section). The wires from many premises are connected to a cable that passes along the street over poles or underground.

When the CPE is activated (eg when the user lifts a telephone handset), the local switch supplies a dial tone to signal the user that the CPE is ready for dialling. The local switch accepts the dialled number, decodes it, and begins the steps necessary to make the connection to the called party. A direct connection occurs when the same switch serves both the calling and called parties. However, if another local switch serves the called party, connection must first be made over transit lines and transit switches to the other switch. The local switch serving the called party makes the final connection. In order to complete the call, one or more switches provide a link for the duration of the call.

CPE equipment accepts the user’s voice, data or video signals and encodes them so that they can be transmitted over the telecommunications network. This CPE equipment may be analogue or digital. Analogue devices encode the user’s signal (voice) into an electrical signal that replicates the energy content of the original signal. Analogue media use continuous wave signals that fluctuate over time (Figure 1.2). Digital devices, on the other hand, measure the height of the signal at frequent intervals and then represent that height with a binary coded number. Therefore, the digital signal is either always high or low (1 or 0) (Figure 1.2). The advantages of digital transmission include lower cost, greater speed, higher quality and the ability to transmit a much wider range of services than analogue systems. The Australian telecommunications network currently includes a mix of analogue and digital equipment.

Figure 1.2: **Analogue and digital signals**



In addition to the CPE permanently located on the customer's premises, there are cellular telecommunications services which provide direct-dial access to mobile handsets. There are also cordless telephone handsets which access a base station by low-powered radio means. The base station has a wired connection to the telecommunications network and it is not possible to use the handsets at a large distance from the base station.

1.3 Transmission facilities

The process of moving information from one point to another is called transmission. Transmission technology has evolved at a rapid pace since electrical communication started in the nineteenth century. The relationship between magnetism and electricity was discovered by Oersted in 1819 and further work was undertaken by Faraday and Ampere in the 1820s. Laboratory systems able to transmit information via the use of rotating magnetised needles became available in the 1820s. In the early 1830s, Gauss and Weber developed a small scale telegraph system. In 1844, Morse set up a telegraph line between Washington DC and Baltimore and in 1849 the first slow telegraph printer link was installed. In 1874, Baudot invented the first carrier system able to transmit up to six telegraph channels onto a single copper wire pair (this process is known as multiplexing and is discussed in detail later). Telephone lines started to appear in the 1890s and around 1920 several voice channels were being multiplexed over one wire pair. Today, thousands of information channels can be carried by a single underlying transmission medium.

While the public was more interested in the development of the telegraph, equally important developments were taking place in the field of radio transmission. In 1840, Joseph Henry, an American, first produced high-frequency oscillation. In 1873, a British scientist, James Clerk Maxwell, tied together the theories of Henry and Morse to explain the theory of propagation of energy from wires. He also showed, at least mathematically, that these generated waves would travel at the speed of light. In 1888, Heinrich Hertz was finally able to demonstrate practically Maxwell's theory. He did so by passing a rapidly alternating current through a wire, creating what were to become known as Hertzian waves. It was left to Guglielmo Marconi to make practical application of Hertz's work. He experimented with an antenna and ground setup from 1895 on, and in 1898 he broadcast the first paid radiogram from the Isle of Wight. The first significant radio applications were for ship communications in the early 1900s. Roughly 10 years later, the first real overseas radio complex was established. In later years, many other services such as television, FM broadcasting, radar and microwave relaying were developed as the unique properties of much higher frequencies were discovered and exploited.

A variety of facilities is required to undertake a transmission. A transmission requires an interconnection medium such as copper wire or coaxial cable or transmission devices that allow the atmosphere and space to be used as transmission media. To superimpose the user signal on to the medium, the transmission equipment needs to modulate a carrier signal. Additionally, the equipment may multiplex a large number of users over the same physical medium.

Transmission medium

Various types of communications media are used for data and telecommunications, and each type of media exhibits its own set of characteristics. One of the most important characteristics of a transmission medium is its capacity or bandwidth. The bandwidth of a transmission medium can be measured either in terms of frequency range or bits per second (bps). The higher the bandwidth of a medium, the larger the range of frequencies that can be carried over it. The number of times a signal can change back and forth between frequencies (signal frequency) determines the number of bps transferred. Therefore, the higher the bandwidth, the higher the signal frequency and the greater possible speed of information transfer.

Transmission media that permit only one signal frequency at a time are called baseband media and are the slowest in terms of bps. Baseband media are often used for telegraph communications. Speeds from 300 bps to about 9 600 bps are typical of voiceband media, often used in telephone lines. Faster speeds require a medium-bandwidth line that can handle speeds ranging from about 9 600 to 256 000 bps. If even faster transmission speeds are required a broadband or wideband medium may be used. These have speeds ranging from 256 000 to about 1 million bps.

The bandwidth that can be carried over transmission systems has increased rapidly over time. In the 1950s, 1 860 voice channels could be carried over a coaxial cable. In digital equivalent this corresponds to 5.95×10^8 bps. In the 1970s, some 10 800 voice channels could be carried over a coaxial cable, which is equivalent to 6×10^9 bps. As of 1990, a fibre optic link could carry multiple gigabyte data rates, in the 10^{10} bps range (Minoli 1991). Microwave-based radio systems also achieved similar bandwidth growth, with 2 400 channels in 1950, 16 500 channels in 1973 and 42 000 channels in 1981 (Minoli 1991). Transmission bandwidth may increase even more in the future, particularly considering the potential of fibre optic technology.

Different communications media connect systems in different ways. Some media send signals along physical connections like wire, while others send signals through the atmosphere by light and radio waves. Generally, three types of transmission cables physically connect telecommunications devices: twisted-pair wire cable, coaxial cable and fibre optic cable. Microwave and satellite transmissions are sent through the atmosphere and space, while a cellular transmission may send signals through both the atmosphere and through physical connections.

Twisted-pair wire cable

Twisted-pair wire cable is, as expected, a cable consisting of pairs of twisted wires. A typical cable will contain two or more twisted pairs of wire, usually copper. The twist helps the signal from 'bleeding' into the next pair. The twisted-pair wires are insulated so they can be placed close together and packaged in one group. Literally hundreds of wire pairs can be grouped into one large wire cable. The vast majority of connections between the local switch and customer premises in Australia are provided by twisted copper pair wires.

There are two kinds of twisted-pair wire cables: shielded and unshielded. Shielded twisted-pair wire cable has a special conducting layer within the normal insulation. This conducting layer makes the cable less prone to electrical interference. Unshielded twisted-pair wire lacks this special insulation shield. The bandwidth for twisted-pair wire is about 4 000 hertz, making it ideal for voice transmission.

The primary advantage of twisted-pair wire cabling is that it is relatively inexpensive to purchase and install. As cabling costs represent over half the cost of many telecommunications installations, this advantage is significant (Stair 1996). The principal disadvantages of twisted-pair wire cable are that it does not support data transfer rates as high as other forms of cabling and it takes up more space than other cables.

Coaxial cable

A coaxial cable consists of an inner conductor wire surrounded by insulation, called the dielectric. The dielectric is surrounded by a conductive shield, usually a layer of foil or metal braiding, which in turn is covered by a layer of nonconductive insulation called the jacket. Coaxial cable, like twisted-pair copper wire, can be grouped together in one large cable. Coaxial cable offers cleaner and crisper data transmission than twisted-pair wire cable. It also offers a higher data transmission rate.

Fibre optic cable

Fibre optic cable, which consists of thousands of extremely thin strands of glass or plastic bound together in a sheathing, transmits signals with light beams. These high-intensity light beams are generated by lasers and are conducted along the transparent fibres. These fibres have a thin coating, called cladding, which effectively works like a mirror, preventing the light from leaking out of the fibre. Because it transmits via light rather than electricity, fibre optic cable has some major advantages over other forms of cabling. Fibre optic cable is capable of supporting tremendous data transfer rates — upward of 2.5 billion bps or 32 000 long-distance phone calls simultaneously with a bandwidth of 200 trillion hertz or more. Optical fibre cables are also smaller in size and reliable over long distances as they are immune to electrical interference.

Microwave and satellite transmission

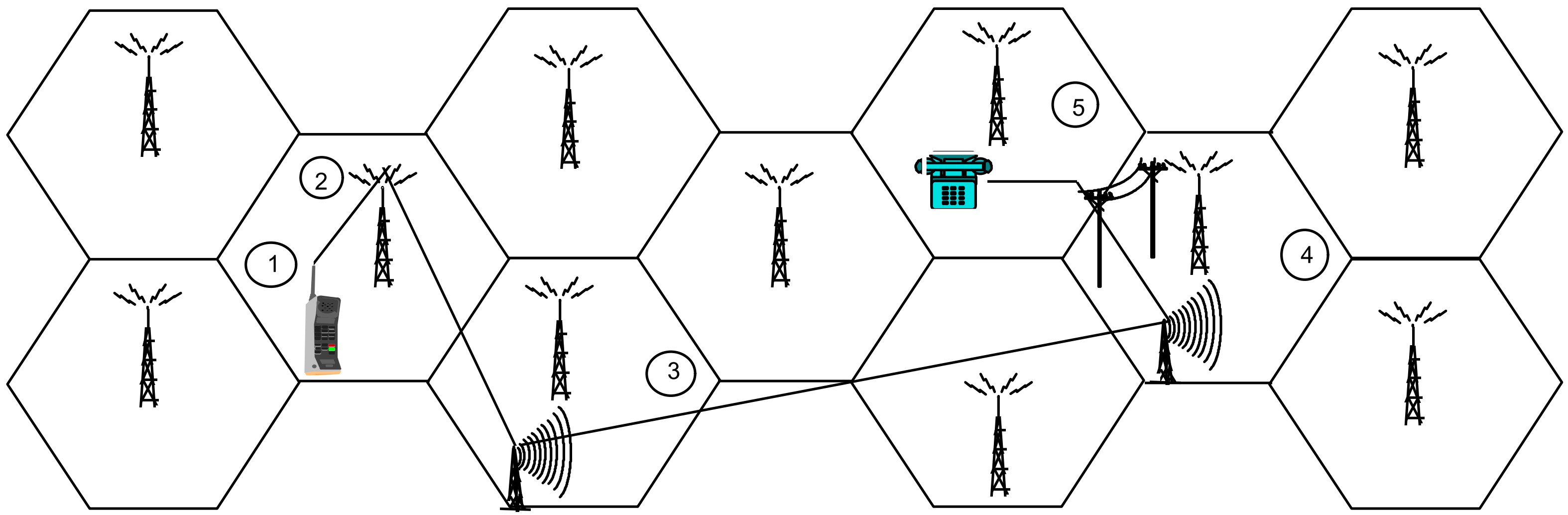
Microwave and satellite transmissions are sent through the atmosphere and space. Although these transmission media do not involve the expense of laying cable, the transmission devices needed to utilise these media are expensive. Microwave transmission consists of a high frequency radio signal that is sent through the air. Microwave transmission is line-of-sight, which means that the straight line between the transmitter and receiver must be unobstructed. To achieve long transmission distances, microwave stations are placed in a series — one station will receive a signal, amplify it and retransmit it to the next microwave transmission tower. Microwaves can carry thousands of channels at the same time.

A communication satellite is basically a microwave station placed in outer space. The signal is received by the satellite and then rebroadcast at a different frequency. The advantage of satellite communication is that it can transmit data quickly over long distances. It also overcomes the problems of the curvature of the earth, mountains and other structures that block the line-of-sight of microwave transmission.

Cellular transmission

Cellular transmission operates through a system of microwave cells which enable customers to transmit and receive calls while moving. A region is divided into geographic cells, with each cell having its own radio-transceiver base station to link to individual mobile handsets. An area is divided into cells in order to get greater use of the scarce radio spectrum. A car or person with a cellular device such as a mobile phone is tracked as it moves across cells and their call is transferred to another base station as the user moves from one cell to another (Figure 1.3). All base stations are linked to the central mobile telephone exchange which in turn is connected to the PSTN. Cellular phone users can thus connect to anyone that has access to the regular phone service or other cellular phone users.

Figure 1.3: **A typical cellular transmission scenario**



1 Using a mobile phone, the caller dials a long-distance number.
2 The signal is sent to the regional cellular phone switching office.
3 The signal is switched to the local telephone switching station located nearest the call destination.
4 Now integrated into the regular phone system, the call is automatically switched to the number originally dialled.
5 All this occurs without the need for operator assistance.

Cellular mobile telecommunications services in Australia are currently provided using two technologies: the analogue Advanced Mobile Phone System (AMPS) technology and the digital Global System for Mobiles (GSM) technology.

The AMPS network started operation in 1987 and is owned and operated by Telstra. AMPS services are retailed to consumers by both Telstra and Optus, with Optus buying capacity on the network from Telstra. The AMPS accounts for most mobile services in Australia but is being phased out over the period from 1996 to 2000 (BTCE 1995).

Digital GSM networks were established by the three licensed mobile carriers (Telstra, Optus and Vodafone) in 1993. By late 1994, the largest of these networks provided access to areas containing around 75 per cent of the Australian population (BTCE 1995). In 1996, mobile carriers claimed that over 90 per cent of the Australian population is covered by digital mobile networks.

Cost considerations of transmission media

Which of these medium technologies is cheapest to employ in different parts of a network depends on a number of factors. Over long distances these factors are the route distance and the cross section of the circuit. For example, US figures for the late 1980s indicate that at a cross section of about 6 000 voice circuits, microwave transmission would be used for short routes and satellites for long routes. At a cross section of 20 000 voice circuits, fibre would be used for short routes and satellite for long routes, and at a cross section of 40 000 voice circuits fibre would be used for both (Minoli 1991). The choice of which medium to use in the CAN depends on span length (the distance from the local exchange) and the required capacity. For Australia, the infrastructure costs of providing residential information services using optical fibre have been estimated to be prohibitive given the current state of technology (BTCE 1994b). However, recent studies have demonstrated that the costs will fall with the growth of mass markets (Senate Economics References Committee 1995).

Modulation

Modulation is the process of interpreting a signal carrying voice or data to make it compatible with a different transmission medium. Modulation alters a signal to enable it to be transmitted on a different frequency. Modulation improves the efficiency of a transmission by increasing the transmission capacity of a telecommunications channel through the use of higher frequencies (Blyth and Blyth 1985).

Two commonly used methods of modulation are amplitude and frequency modulation (Figure 1.4). Both amplitude and frequency modulation (AM and

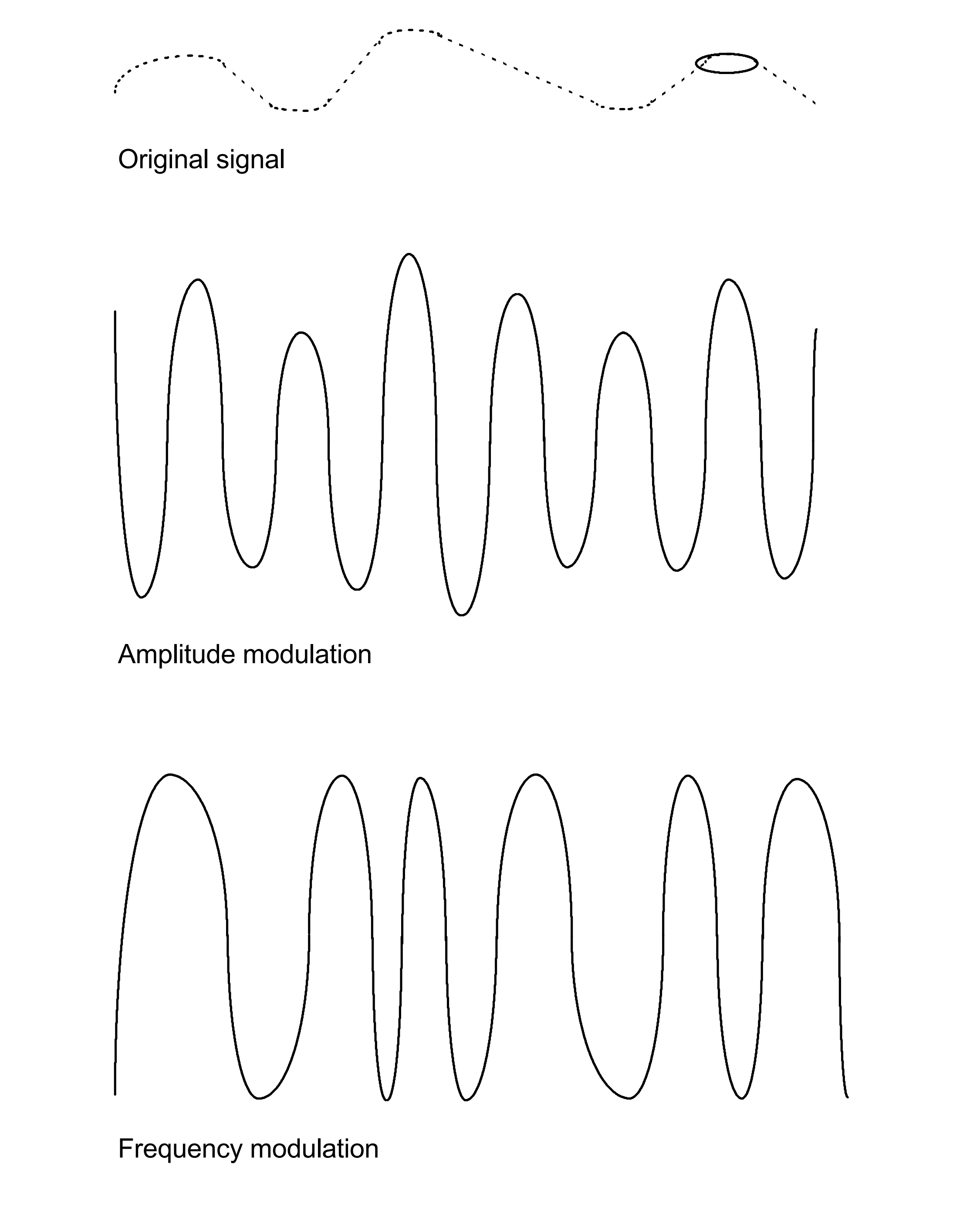
FM) methods are used for modulating radio signals in radio broadcasting. Amplitude modulation is the process whereby the intelligence of the signal is represented by variations in its amplitude or strength. Frequency modulation is the process whereby the intelligence of the signal is represented by the variations in the frequency of the oscillation of the signal. Another type of modulation, called phase modulation, is used in digital modulation for data transmission applications. Phase modulation is similar in some respects to frequency modulation, with the phase of the transmitter being increased or decreased in accordance with the modulating intelligence signal.

The piece of equipment that performs the conversion of signals to analogue signals and back again is called a modem (from modulator/demodulator). Modems can use amplitude, frequency or phase modulation or a combination of these to send data signals over an analogue carrier. Each method impresses the data on a carrier signal, which is altered to carry the properties of the digital data stream.

The development of the modem began in 1919 with research into methods for sending graphic information over a voice network (Minoli 1991). Between 1919 and the mid-1950s research focused primarily on the basic properties of copper lines and on basic theories of data communication. The maximum data rate was around 100 bps. Starting in the mid-1950s, growing military requirements and commercial interest in transmitting large amounts of data, led to efforts to achieve greater transmission speeds. These efforts resulted in an increase in the speed from 100 bps to 9 600 bps in the late 1960s. During the 1970s, the speed of commercially available modems remained around 9 600 bps, but major design improvements led to significant reductions in size and increases in power. During the 1980s, error-correcting modems, advanced signal processing and higher speeds were introduced. Speeds of 19 200 bps are now routinely possible on dedicated lines.

In spite of predictions over the past decade that modems would soon be eliminated by end-to-end digital networks, a large proportion of data communication in the 1990s is still carried by voiceband modems over the analogue telephone network. Effective bandwidth has increased approximately 30-fold during the past decade, and the cost per bps has decreased 20-fold. In the early 1980s, a 1 200 bps modem cost $1 000, resulting in a cost of 83 cents per bps; in 1987 the cost decreased to 20 cents per bps and in 1990 modems with a cost of 6 cents per bps were available (Minoli 1991).

Figure 1.4: **Amplitude and frequency modulation**

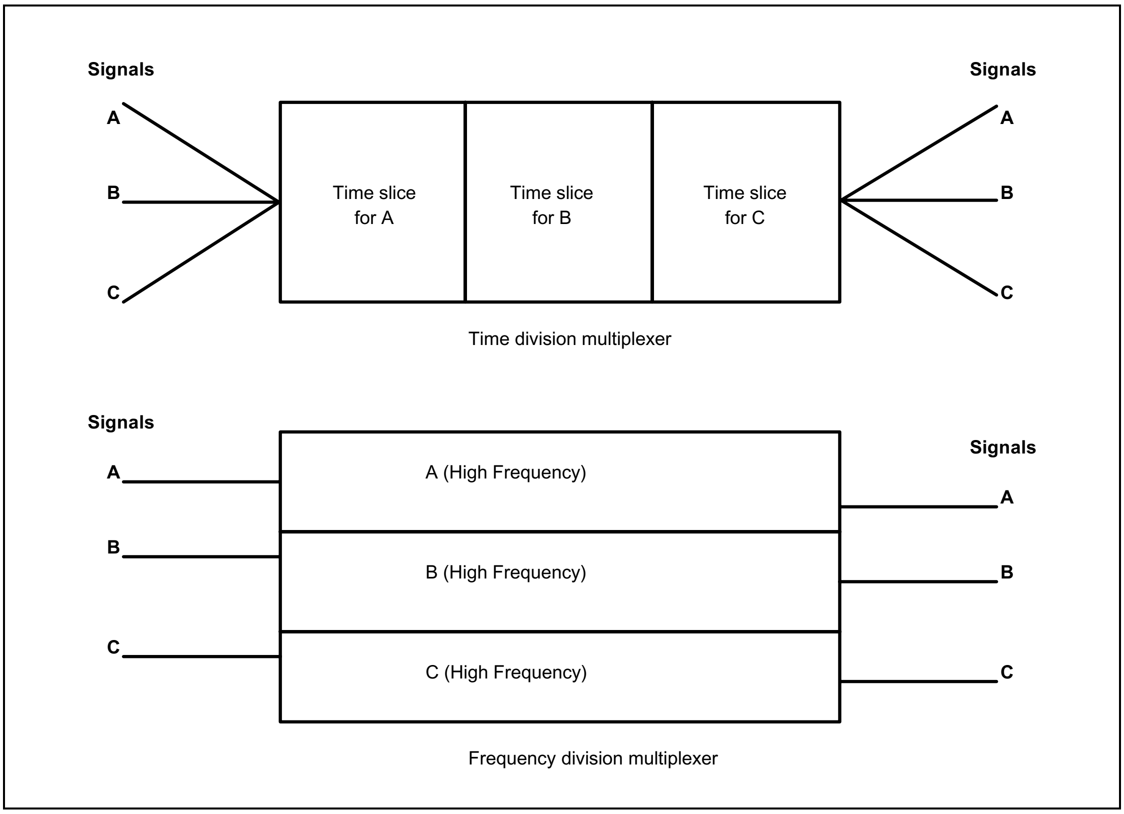


Multiplexing

A multiplexer allows several telecommunications signals to be transmitted over a single communications medium at the same time. A multiplexer combines a number of low speed channels into one higher speed channel at one end of a transmission and divides them into low speed channels at the other end. The process permits a voice-grade channel to carry two or more narrowband channels and similarly a wideband channel can carry several voiceband channels. Multiplexing reduces line costs by increasing the number of lines that can be carried by a communications channel.

There are two main types of multiplexers (Figure 1.5). A time division multiplexer (TDM) slices multiple incoming signals into small time intervals. Then the multiple incoming lines are merged into time slices that go over a communications line. At the receiving end, another TDM splits the time slices into separate signals again. With a frequency division multiplexer (FDM) the incoming signals are placed on different frequency ranges and sent across the telecommunications medium at the same time. At the receiving end, another FDM splits the frequencies into multiple signals again. TDMs are usually less expensive than FDMs.

Figure 1.5: **Multiplexers**



1.4 Switching equipment

The first telephone lines were strung directly from one individual telephone to another — no central point intervened. As more telephones came into use and more wires were strung, it became apparent that stringing direct lines between separate instruments was no longer feasible. In addition, the value of the telephone would be substantially increased if it were connected to more than one other telephone. Thus, the process of transferring a connection from one telephone circuit to another by interconnecting the two circuits was developed. This process is known as switching. The central office or telephone exchange came into being as a switching centre — a point at which two circuits could be interconnected to make a talking path between two telephones. Originally an operator manually connected telephone lines to each other. In the 1920s, manual switching began to be replaced by automatic exchanges, in which the caller dials the desired number directly to effect the connection between the two telephones.

The first automatic switch was invented by a Kansas City undertaker, Almon Strowger. According to tradition, Strowger suspected the local telephone operator of misdirecting calls intended for him to his competitor, who was a relative of the operator (Blyth and Blyth 1985). Accordingly, he vowed to find a way to eliminate the need for operators and commenced work on the development of an automatic switching device. In 1891 a patent was issued to Strowger for a two-motion (vertical and horizontal) switch that was subsequently named the Strowger switch. The principle on which Strowger's invention was based was so fundamental to automatic telephone systems that for many years telephone companies had to obtain a licence from him before updating their equipment.

The earliest automatic central offices were equipped with step-by-step systems which offered a means of selecting a series of paths through which the circuit from the calling party to the called party could be progressively established. The number of telephone lines operated by this system was limited and, although very reliable, the system was slow by today's standards. In addition, if a call was blocked by equipment in use, the system was incapable of rerouting the call. A control method that eliminated these problems was introduced after 1940. Much of the control function to direct the path that the call takes through the system is concentrated in a small number of pieces of equipment and these are used repeatedly. A unit of control equipment performs its function on a call and then becomes immediately available to perform the same function on another call. This mode of operation is known as common control.

Common control hardware can be electromechanical or hard-wired electronic (as was the case until the early 1960s) or can be computerised (which was introduced in 1965). Replacing hard-wired common control systems with a programmable computer resulted in options being supplied more easily to users and made new services possible. These systems are referred to as stored program control (SPC). With SPC, the control of the switching functions is achieved by instructions stored in the memory of a computer and new service features may be added by changing the contents of the machine's memory. Examples of such services include speed calling, call-waiting and call forwarding.

Telephone switches are interconnected by a group of circuits called interoffice trunks. Typically these trunks are pooled, meaning that they can be seized by switches at either end and put on line as needed. Two exchanges which are connected directly via a system of trunks are said to have direct trunks between them. In telephone networks with a large number of exchanges, having trunks between every pair of switches is not practical. In these cases, the local telephone exchanges are connected to trunks that can provide access to an intermediate switching centre (transit or secondary switching centre), to which all switches are in turn connected. These transit switches can then be connected to regional or national switches.

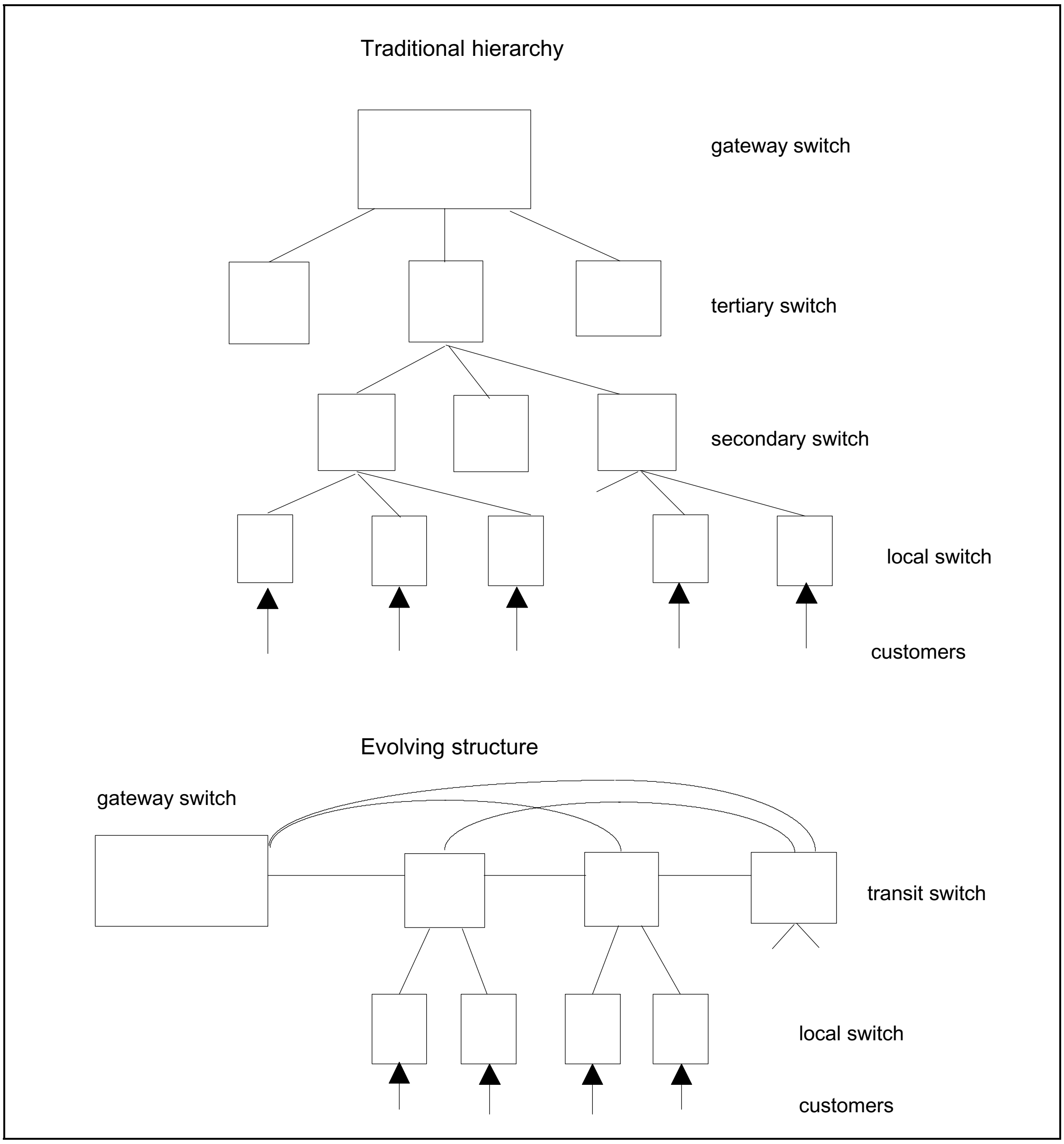
In Australia there are currently two layers of transit switches in the basic network (Figure 1.6). They involve secondary switches, which collect and distribute traffic for groups of local switches (for example, covering several suburbs in a city) and tertiary switches which collect and distribute traffic for groups of secondary switches (for example, covering a city or a major part of a city). The network is currently evolving to a single layer of transit switches (Figure 1.6). The move towards a less hierarchical system of switches has been made possible by the evolution of technology that allows more calls to be transmitted over a given medium, which in turn increases efficiency and reduces costs.

The local switch connects users in the same CAN, links calls to other switches and performs several other functions (BTCE 1995). When the user lifts a handset, the local switch accepts the dialled number, decodes it, and begins the steps necessary to make the connection to the called party. For an incoming call, the local switch senses the direct current which flows when the handset is lifted by the called party. The switch then stops the telephone ringer voltage, which is connected in parallel with the voice line.

In a PSTN, users share common switching equipment and channels which require the establishment of an end-to end circuit for the duration of each call.

A line is dedicated to the call and no other call can use the line until the original connection is closed.

Figure 1.6: **Switching systems**



An alternative method, called packet switching, is often used to transfer data over networks. In packet transmission a data message is divided into discrete units called packets that are routed individually over the network. Since each of the various packets of the message can be routed over different transmission facilities, they may arrive out of sequence. Each packet contains control information that enables the message to be reassembled in proper sequence before it reaches its final destination. Packet switching allows more efficient utilisation of the available network for interactive data communications because packets use the network only for the brief time they are in transit, in contrast to circuit switched messages that require the use of the line for the duration of the message.

Another switching method is provided by private automatic branch exchanges. A PABX is a communication system that can manage both voice and data transfer within a building and to outside lines. Many of the modern features of the PABX are a result of the computerised capabilities of the SPC, originally developed for exchange switches. In a PABX system, switching equipment routes phone calls and messages within the building. PABXs can be used to connect many phones or phone lines to a small number of company phone lines. Thus, a major advantage of a PABX system is that it requires a business to have fewer phone lines coming in from the outside. The disadvantage is that the company has to purchase, rent or lease the PABX equipment.

Integrated Services Digital Network provides another switching method. ISDN is a technology that uses existing common-carrier lines simultaneously to transmit voice, video and image data in digital form. ISDN also offers high rates of transmission. With ISDN, devices to convert signals from digital to analogue and back are not needed. These data communications systems use an ISDN network switch, a digital switch that allows different communications services to be connected to the system. For example, ISDN allows long-distance services, video and voice services, facsimile devices, telephones and PABXs to be integrated into one telecommunications system. ISDN digital networks are typically faster and can carry more signals than analogue networks. They also allow for easier sharing of image, multi-media and other complex forms of data across telephone lines.

However, implementation of ISDN applications has been slow, partly because only a few countries have implemented operational networks. ISDN has been available in Australia since the late 1980s (BTCE 1995). With the emergence of broadband ISDN, there will be significant benefits to users through increased bandwidth availability and the ability of suppliers to provide variable bandwidth to suit end-to-end application requirements.

1.5 Summary

A telecommunications network comprises a number of smaller networks. The customer access network connects the caller to the local switch. The local exchange network connects the local switches to higher level transit switches. Together, the CAN and the LEN make up the local network. Therefore, the local network carries local traffic and reticulates higher level telecommunications traffic (long-distance and international). The long-distance network carries STD traffic from one local network to another. The international network carries calls from the international gateway exchange to the mid-point of the international circuit.

Telephone calls and data travel over the network via a variety of transmission media including physical cables and the atmosphere. The signal (voice or data) is superimposed on to the medium by transmission equipment which modulates the signal. Transmission equipment may also multiplex signals over the same medium at the same time to reduce line costs.

Switching equipment connects two circuits to establish an end-to-end circuit for the duration of each call. In Australia, secondary switches collect and distribute traffic for groups of local switches and tertiary switches collect and distribute traffic for groups of secondary switches. The PSTN uses common switching equipment. However, a variety of alternative switching methods are also used including PABX, packet switching, and ISDN switching.

2 ECONOMIES OF SCALE AND SCOPE IN TELECOMMUNICATIONS

Whether the local network is a natural monopoly hinges in part on whether there are significant economies of scale and/or scope. Although this has been the focus of many empirical studies over the last two decades, it has never been fully resolved. Many of the cost or production functions estimated to test for natural monopoly have been based on limited time series data from two large telephone utilities, AT&T and Bell Canada. A number of economists have estimated single-output and multi-output cost functions using different methods to control for technological changes over time, yet their assessments of natural monopoly have produced inconsistent results.

This chapter briefly reviews recent empirical studies on natural monopoly in the local network and finds that even some of the recent studies reach opposing conclusions.

2.1 Characteristics of a natural monopoly

A natural monopoly can arise from economies of scale and/or economies of scope. Economies of scale exist if the marginal costs of production are less than the average costs of production over the relevant range of output. Economies of scale can arise from many different technological factors. A prevalent source of economies of scale is fixed costs, that is, costs that must be incurred no matter how many units of output are produced. Fixed costs are thought to be significant in telecommunications and in other industries that require networks such as postal services, railways, natural gas pipelines and electricity transmission.

When more than one output or service is being produced, natural monopoly can arise from economies of scope as well as economies of scale. With several goods, there is sometimes shared equipment or common facilities that make producing the goods together less expensive than producing them separately. Economies of scope are said to exist if a given quantity of each of two or more goods can be produced by one firm at a lower total cost than if each good were produced separately by different firms.

Economies of scope can exist with or without economies of scale, and vice versa. Whether a natural monopoly exists depends in part on the overall cost situation, considering both economies or diseconomies of scope and/or scale. The concept of *subadditivity* is used for this purpose. For a firm to be a natural monopoly its cost function must be strictly and globally subadditive — every conceivable way of dividing its outputs among two or more firms must lead to higher total costs than if the outputs were produced by the single firm.

Economies of scope and declining average incremental cost for each service are sufficient to ensure subadditivity. However, while economies of scope are necessary for subadditivity, declining average incremental cost is not — the property of subadditivity can still be present even at outputs where there are diseconomies of scale.

However, the property of subadditivity ensures natural monopoly only when any new entrant has access to (or is constrained to use) the same technology as the incumbent. If an entrant instead uses a lower-cost technology and can provide the entire market at lower resource cost than the incumbent, then its entry (and the incumbent's demise) would be socially optimal. In an industry undergoing rapid advances in technology, this is an important proviso.

A natural monopoly also presupposes that market coordination between separate firms (say by networking, pooling or interconnecting) is unable to achieve the same economies as internal coordination within a single firm. With the increasing unbundling and interconnection of telecommunications services, it is not clear that this presupposition holds (see also Chapter 7).

2.2 Review of empirical studies examining natural monopoly in the local network[1]

There is a range of literature examining the necessary conditions which guarantee that an industry is a natural monopoly (Sharkey 1982; Baumol, Panzar and Willig 1982; Train 1991). Many of these studies suggest that global information about cost functions is required to determine the presence of natural monopoly. However, such information is seldom available. To overcome these data limitations, Evans and Heckman (1984) proposed a new test of natural monopoly that does not require global information on firm cost functions. They test for subadditivity within a region that avoids the need to extrapolate outside

[1] The LEN is the set of equipment for switching and inter-exchange carriage of telecommunications traffic. The LEN carries local call traffic as well as reticulating higher level traffic (eg long-distance calls) into and out of the CAN. The LEN and the CAN together make up the 'local network' (see Chapter 1).

the range of the available data. The test is based on the idea that, if subadditivity is rejected in one region, global subadditivity must be rejected (but acceptance of subadditivity within one region does not imply global subadditivity). The Evans and Heckman (1984) local test for subadditivity has since been used in a number of studies which examine the existence of natural monopoly. The first use of the test, however, was by Evans and Heckman (1984) who applied it to data from the US Bell System over the period 1947 to 1977.

Evans and Heckman (1984) report that their estimated cost function was monotonically increasing and concave with respect to input prices in all years. Their estimated own-price elasticities of demand for capital, labour and materials were negative in all years. Therefore, Evans and Heckman (1984) conclude that their estimates satisfy the conditions required of an economically valid cost function.

They then test for subadditivity directly. They find that the maximum percentage cost saving from multifirm production versus single firm production was always greater than zero and often statistically significantly different from zero for output configurations produced between 1958 and 1977. Evans and Heckman (1984) therefore reject the hypothesis that the Bell System's cost function is subadditive at the output levels produced between 1958 and 1977.

However, two more recent studies, which use the same data as Evans and Heckman (1984), arrive at opposite findings.

Röller (1990) claims to improve on the Evans and Heckman (1984) study in two ways. First, he uses a quadratic cost function, which he argues is better suited for multi-output cost models than the translog model used by Evans and Heckman (1984). Second, he constrains the cost function to satisfy a property termed 'properness' in order to ensure a well-behaved, economically plausible cost function in light of the limited information contained in the data. A proper cost function as defined by Röller (1990) has non-negative marginal costs, is non-negative and is homogeneous, monotonic and concave in input prices.

Röller (1990) estimates a cost function which is constrained by 'properness'. He finds that rather strong economies of scope and economies of scale seem to exist. In addition, he tests for subadditivity of the cost function, using the Evans and Heckman (1984) local test for subadditivity, and finds that in all years divestiture would increase costs. Röller (1990) concludes that his findings suggest that the data are consistent with the natural monopoly hypothesis.

The second study, by Charnes, Cooper and Sueyoshi (1988), claims to utilise the same data and functional form as the Evans and Heckman (1984) analysis and also comes to the opposing conclusion — local networks are natural monopolies. However, Evans and Heckman (1988) argue that the Charnes, Cooper and Sueyoshi (1988) goal programming/constrained regression methodology makes a comparison of the two studies impractical.

Shin and Ying (1992) claim that one of the major problems with natural monopoly studies, including the Evans and Heckman (1984), Röller (1990) and Charnes et al (1988) studies, is the choice of data and level of aggregation. They argue that, because previous studies have all relied on aggregate time series data consisting of a small number of observations of highly correlated variables, the results have been sensitive to specification and estimation techniques. Shin and Ying (1992) observe that past researchers may have obtained biased estimates of scale elasticities since the output and technological change variables are highly correlated over time. In addition, as pointed out by Shin (1988), if technological changes are rapid and large and are not properly captured, then it is possible that even if no scale economies are present in the relevant ranges, the time series estimations can produce a cost function that exhibits high apparent economies of scale.

Shin and Ying (1992) attempt to overcome these data problems by examining the subadditivity of local networks using pooled cross-sectional data from 58 local networks over the period 1976 to 1983 for the United States. They estimate a multiproduct cost function where the basic output variables are the average number of access lines or telephones, and numbers of local calls and toll calls (as opposed to deflated revenues). The estimated coefficients on the three output variables are all positive, less than one and highly significant. The overall scale elasticity is calculated by summing the output cost elasticities for the individual services. At the sample mean for all variables, it equals 0.958. Therefore, increasing access lines, local and toll calls by 1 per cent increases costs by slightly less than 1 per cent, indicating mild scale economies. However, Shin and Ying (1992) note that these calculations do not necessarily suggest that local networks are natural monopolies, since this requires the cost function to be subadditive.

Shin and Ying (1992) construct a range of hypothetical output configurations by dividing the monopoly outputs between two firms in a variety of ways. They report detailed comparisons of the estimated costs of these output configurations for one year, 1983. They find that out of 21 170 possible configurations, only 6 985 or 33 per cent result in a single firm being able to produce at a lower cost than two firms. They also find that the degree to which a monopoly is relatively more efficient seems to lessen as the firm's size, as measured by access lines, increases. While the authors concede that the evidence is far from clear-cut, they note that what is unambiguous is that the cost structure of local networks is not globally subadditive and, therefore, the local network is not a natural monopoly. Their summary results for 1976 to 1982 also indicate that costs are not subadditive in any of these years, leading the authors to conclude that AT&T was unlikely to have been a natural monopoly before its break-up.

Shin and Ying (1992) also address Röller's (1990) concern that the test region for subadditivity should be constrained to exhibit positive marginal costs. The author's delete any observations for which negative marginal costs are calculated and find that the average number of times where a single firm is more cost-effective than two firms is even smaller than it is with the full sample for each year. Imposing this additional condition serves to strengthen the case that local networks are not natural monopolies.

The Shin and Ying (1992) study was updated in 1994 using data from 1984–91. Again, Shin and Ying (1994) conclude that local networks are not natural monopolies in the post-divesture era. They find that having two firms produce the monopoly output could potentially result in over 20 per cent cost savings.

However, the findings of another recent study by Gabel and Kennet (1994) conflict with the Shin and Ying (1992) claim that the local network is not a natural monopoly. Gabel and Kennet (1994) observe that the Shin and Ying (1992) study and other empirical studies of natural monopoly in the local network have been constrained by a lack of data. No observations have been available on the cost of having two or more firms serve the same market. A lack of observations for firms which provided only part of the industry vector of outputs has constrained the tests for subadditivity of the cost function to the output region of the observed data. This methodology has not allowed for the possibility that an entrant will offer services with a significantly different vector of outputs and network topology from the incumbent.

To overcome data deficiencies, Gabel and Kennet (1994) generate data using an engineering optimisation model (see Gabel and Kennet (1991) for a detailed explanation of the optimisation model). Since the model allows the estimation of costs for stand-alone telecommunications networks, the authors are able to compare the cost of a single network which is required to carry four distinct outputs (toll and local switched services and toll and local private lines) with the costs of various combinations of specialty networks.

Gabel and Kennet (1994) use the data from their model to address the issue of economies of scope which is a necessary, but not sufficient, condition for a natural monopoly. In order to determine the extent to which there are economies of scope, Gabel and Kennet (1994) calculate and compare the cost of providing four services (exchange switch service, toll switched service, local private line service and toll private line service) on one network with the cost of providing the four services on two or more networks. Economies of scope were found to be present in twelve of the fourteen combinations of different networks offering different services. These estimates were made for a region that had 22 037 customers per square mile — in the range found in high density residential neighbourhoods, but considerably lower than found in high density business districts. Gabel and Kennet (1994) find that, as customer density increases above this average, economies of scope dissipate. In two very densely populated areas, the optimisation model shows that cost savings are achieved by having separate networks for switched and non-switched (private line) services. Gabel and Kennet (1994) also find economies of scope between toll switched and exchange switched services for a large range of customer densities. They argue these derive from the shared nature of the local loop.

All of the above studies examined the natural monopoly question with reference to the United States. However, a recent study by Gentzoglanis (1993) examines the question of natural monopoly for a relatively small Canadian telecommunications carrier, Alberta Government Telephones (AGT), over the period 1968 to 1985.

The Evans and Heckman (1984) local test for subadditivity was carried out by estimating a multi-output, multi-input translog cost function. Outputs for AGT were grouped into local and long-distance service outputs. Most of the parameter estimates in the model were found to be statistically significant with the t-ratios for local and long-distance outputs reported as 3.2 and 2.3 respectively. The production structure of AGT was found to exhibit moderate scale economies. The cross-output interaction parameter (local/toll) was estimated to be negative and statistically significant from zero, indicating that cost savings are realised as a result of producing together both local and toll services (economies of scope).

The test for subadditivity revealed that AGT’s production costs are lower than the sum of the costs of two separate entities in each of the years for which the subadditivity test was performed (1974 to 1985). The authors conclude that, while their estimations were obtained using relatively few sample observations and hence need to be interpreted cautiously, their results do suggest that structural deregulation may not be the appropriate means for increasing allocative efficiency in AGT’s market.

2.3 Conclusion

Recent empirical tests for natural monopoly still rely primarily on data from large incumbent telecommunications carriers, data that display only limited variation over time and contain relatively few observations for the number of parameters being estimated. This makes the results very sensitive to specification and estimation techniques. As a consequence, natural monopoly studies have produced mixed and inconclusive results. Even where identical data are used, conflicting results can be obtained. The two studies which use larger samples, Shin and Ying (1992) and Gabel and Kennet (1994), also obtain conflicting results. Therefore, there is little information that can be drawn from these studies that is relevant to Australian circumstances, except that no conclusive empirical evidence exists which proves or disproves that the local network has cost characteristics conducive to a natural monopoly.

3 DEMAND FOR TELECOMMUNICATIONS SERVICES

This chapter sets out the factors that determine the demand for telecommunications access and services and reviews a wide range of telecommunications demand literature from both Australia and overseas. A primary aim is to obtain an impression of the size of price elasticities of demand for telephone services in Australia, and any interdependencies between them. Price elasticities of demand are surveyed for customer access, local calls, long-distance calls and international calls. In addition, a few recent Australian studies of the demand for broadband services are discussed. These price elasticities can play an important role in determining the structure of second-best prices for final telephone services.

3.1 Telecommunications demand

There are several features of telecommunications demand which distinguish it from the demand for other goods and services. One of these, shared with other network industries, is that the consumption of telecommunications services requires access to the telecommunications network. Customer access can occur through the fixed wire attachment of a CPE, or through a wireless ('mobile') connection. The network can also be accessed through public telephones. The demand for customer access arises both as a derived demand from the demand for services, and as an option demand.

The relationship between the demand for access and the demand for use of the system has been analysed by Squire (1973). The willingness to pay for access depends in part on the consumer's surplus arising from use of the system. A reduction in prices for use will increase this surplus and make access more valuable; conversely, an increase in use prices will reduce willingness to pay for customer access. The demand for access will depend on both the price of access and the price of services consumed.

Another determinant of access demand arises because benefits accrue not only from completed calls, but also from calls that may not be made. Subscribing to the telephone network can be viewed as the purchase of options to make and receive calls (Taylor 1994). For example, a consumer may value the option to make an emergency call such as to the fire brigade, police or ambulance, but may never actually make the call. Option demand is, therefore, an important characteristic of telephone demand.

Another characteristic that distinguishes telecommunications demand from the demand for most goods and services is the fact that telecommunications services are not consumed in isolation (Taylor 1994). The complexities of a telecommunications network give rise to certain interdependencies and externalities which affect how the demand for telecommunications is modelled.

The demand for telephone services is generally modelled in terms of how many consumers subscribe to the service at various access and call prices, and then how many calls those consumers make at various call prices. While this approach provides useful results, it does not take into account demand externalities. A completed telephone call requires the participation of a second party, and the utility of this party is thereby affected (usually benefited). This is the first of two demand externalities associated with the telephone and is usually referred to as the *call* or *use externality*. A second type of externality arises when a new subscriber connects to the system. Connection of a new subscriber confers a benefit on existing subscribers because the number of telephones (and other CPEs) that can be reached is increased. This externality is usually referred to as the *network externality*.

Finally, telephone calls may come in a variety of shapes and forms (time of day, distance and duration) which need to be taken into account when modelling telecommunications demand. The distinction between peak and off-peak demands is particularly important.

The remainder of this chapter presents the results of studies of five types of telecommunications demand: customer access, local calls, long-distance calls, international calls and broadband services. Additional details of each of the studies are provided in Appendix A.

3.2 Customer access

As discussed above, there is an important distinction and relationship between demand for access to the telephone system and demand for use of the system. Squire (1973), using a consumer surplus framework, showed that a consumer will demand access to the telephone system if the benefits from belonging to the system (measured by the consumer's surplus associated with the calls that would be made) are at least as great as the cost of subscribing to the system. Therefore, demand for access to the telephone system depends in a fundamental way on the demand for use of the system.

Appendix A describes five empirical studies of the demand for customer access. The five empirical studies all used a binary choice logit or probit model that related the probability of a household having a telephone to the price of access, income and a range of socio-demographic variables. All of the statistically significant estimates from each of the studies found that the probability of having a telephone varied negatively with the price of customer access, but in aggregate this variation was small.

Table 3.1 summarises the estimated price elasticities of each of the studies. Only Cain and MacDonald (1991) calculated an elasticity of demand for access with respect to the connection charge. Their estimate of -0.038 is comparable with those found by Taylor in his 1980 review of telecommunications demand literature. Taylor (1980) concluded, from his interpretation of the empirical record, that the elasticity of demand for access was -0.030 with respect to the service connection charge.

There appears to be less agreement on the elasticity of demand for access with respect to the monthly service charge. Perl (1984) and Taylor and Kridel (1990) estimated the change in demand for access with respect to changes in both the flat rate and measured rate monthly access charges and reported similar elasticity estimates. Cain and MacDonald (1991), on the other hand, estimated the change in access demand with respect to changes in the flat rate and measured rate access charges separately. Their results indicated that the demand for access is more elastic with respect to the flat rate charge than the measured rate access charge. The Canadian study (Bodnar et al 1988) estimated a much smaller elasticity of demand for access with respect to the access price than the US studies. However, this is a result of a higher telephone penetration rate in Canada compared with the United States. When the telephone penetration rate is changed to the US level, the Canadian results are very similar to those of the US studies. Taylor (1980) concluded that the elasticity of demand with respect to the monthly service charge was -0.1, which is considerably more elastic than the estimates from the studies reviewed here.

The only Australian study reviewed in this section (Madden et al 1993) included the access charge as part of the income variable, making it difficult to compare with the other studies.

Table 3.1: **Summary of price elasticities of demand for access**

Study	*Price elasticity of demand for access*	*t-ratio*
Perl (1984) (United States)	-0.038 measured at a flat rate access charge of $10 per month or a measured rate access charge of $6 per month at an initial telephone penetration rate of 0.93	2.5 for flat rate price 2.1 for measured rate access price
Taylor and Kridel (1990) (United States)	-0.037 measured for a 1 per cent increase in flat rate and measured rate access charges at an initial penetration rate of 0.93	not available
Cain and MacDonald (1991) (United States)	-0.038 measured for an increase in connection charge from $45 to $55 at an initial penetration rate of 0.95	2.4
	-0.096 measured for an increase in flat rate from $15 to $17.50 at an initial penetration rate of 0.95	2.7
	-0.048 measured for an increase in measured rate access charge from $7.50 to $10 at an initial penetration rate of 0.95	4.4
Bodnar, Dilworth and Iacono (1988) (Canada)	-0.009 measured for a 1 per cent change in 1985 residence access price at an initial penetration rate of .98	2.4
Madden, Bloch and Hensher (1993) (Australia)	-0.003 with respect to cents per minute for the distance time calling band 'Day 0-10 km'	greater than 2 (significant at the 5 per cent level)

In addition, the studies reviewed here concluded that demographic characteristics also have a significant effect on the probability of having access to the telecommunications network. In particular, most of the studies found that households that are most likely to disconnect from the telephone systems as a result of rising local rates would be young, low-income, poorly-educated households living in rural areas.

The studies reviewed here dealt only with residential access to telephone systems, ignoring the demand for access by businesses. This is because it appears that no business today could be without a telephone service. Accordingly, to approach business demand in an access/no access framework as with residential demand is simply not relevant (Taylor 1994). This does not imply that all businesses necessarily have telephones, it just suggests that the reasons for not having them are almost certainly noneconomic (Taylor 1994).

3.3 Local calls

There have been few Australian studies of demand for local calls and hence most of the studies reviewed here examine local call data from overseas. When transcribing the results of overseas studies of demand for local calls to the Australian situation, care needs to be taken because of the fundamental difference in tariff structures that apply. In particular, flat rate structures have commonly been applied in the past in the United States, with unlimited local calls being permitted once a flat monthly fee has been paid. Under such a scheme, the number of local calls made by customers will be extremely insensitive to changes in the monthly rate, and it would be misleading to apply these elasticities to Australia directly, where consumers are likely to be more price sensitive because of the unit charge tariff (BTCE 1994a). In some cases the US results are based on tariffing experiments by the telephone companies, and these results are therefore likely to be more transferable to the Australian situation.

The four studies reviewed in detail in Appendix A indicate that the demand for local telephone calls, both in terms of number of calls and minutes, varies negatively with the price per call and the price per minute, although the variation (with the exception of the Madden et al (1993) estimates) is small. In addition to the studies reviewed in Appendix A, there are a number of studies from the 1970s that estimated price elasticities of demand for local telephone calls. Taylor (1980) reviewed a number of these studies and concluded that the price elasticity of demand for local calls was -0.20. A summary of the studies reviewed here and some of those reviewed by Taylor (1980) are presented in Table 3.2. The studies reviewed by Taylor (1980) generally estimated larger elasticities (in absolute terms) than the studies reviewed here, with the exception of Madden et al (1993). In the studies reviewed by Taylor (1980), the dependent variable was price-deflated local call revenue.

The large difference between the Madden et al (1993) elasticity estimate and the lower elasticities estimated in the other studies may be explained, to some extent, by the difference in the Australian and US tariff schemes. As Australian consumers pay for each local call and in many cases US consumers can make unlimited local calls for a flat fee, Australian consumer demand for local calls is likely to be more sensitive to changes in the call charge than in the United States. This notion is supported by the New York Telephone Company (1976) study which found that the elasticities of demand for additional calls were higher than for the basic service, indicating that consumers are more sensitive to price when they are required to pay for each call.

Table 3.2: **Summary of price elasticities of demand for local telephone calls**

Study	*Elasticity*	*t-ratio*
Park, Wetzel and Mitchell (1983) (United States)	-0.08 for number of local calls with respect to per-call charge	5.8
	-0.06 for number of local calls with respect to per-minute charge	4.6
	-0.09 for local call minutes with respect to per-call charge	3.9
	-0.11 for local call minutes with respect to per-minute charge	5.7
Bidwell, Wang and Zona (1995) (United States)	-0.04 for number of local calls with respect to price per call	2.5
Trotter (1996) (United Kingdom)	-0.04 for number of local calls with respect to price per call	not available
Madden, Bloch and Hensher (1993) (Australia)	-0.46 with respect to cents per minute for the distance time calling band 'Night 10-30 km'	greater than 2 (significant at the 5 per cent level)
New York Telephone Company (1976) cited in Taylor (1980) (United States)	-0.35 for residential additional message units	not available
	-0.10 for basic residential service	not available
	-0.18 for business additional message units	not available
	-0.08 for basic business service	not available
Waverman (1974) cited in Taylor (1980) (United States)	-0.27 for residential and business basic service in the short-run	1.5
	-0.38 for residential and business basic service in the long-run	1.5
Davis, Caccappolo and Chaudry (1973) cited in Taylor (1980) (United States)	-0.21 for residential and business basic service in the short-run	not available
	-0.27 for residential and business basic service in the long-run	

The studies reviewed provide little information about the difference in demand elasticities for local calls between residential and business users. However, it is likely that the residential demand for local calls would be more price elastic than business demand. The New York Telephone Company (1976) study reviewed by Taylor (1980) does provide some indication of the size of the difference between residential and business demand, estimating the price elasticity of residential demand for consumers that pay for each call as -0.35, while the corresponding elasticity for business demand was estimated to be -0.18. Taylor (1980) also observed that the price elasticities estimated for the demand for local service were generally in line with the price elasticities for access, providing support for the notion that the US demand for local service is primarily to be identified with the demand for access.

3.4 Long-distance calls

Many of the recent studies on long-distance demand pertain to the US market which has a long-distance telecommunications structure different from Australia. The long-distance telephone service in the United States is based on local access transport areas (LATAs), which are within-state geographical areas consisting of a single population centre (Taylor 1994). The US long-distance market is divided into three segments based on LATAs: intraLATA, interLATA-intrastate and interLATA-interstate. Different US demand studies examine these components of the US long-distance market separately.

The studies reviewed in Appendix A reveal that the demand for long-distance calls varies negatively with price and that the longer the distance of the call, the greater the variation becomes (Table 3.3).

Duncan and Perry (1994) and Train (1993) (and the studies he cites) concluded that the price elasticity of demand was around -0.40 for total minutes of intraLATA calls. However, Martines-Filho and Mayo (1993) estimated significantly larger price elasticities of demand for the number of intraLATA calls between -1.05 and -1.55. A review of the telecommunications demand literature in 1980 led Taylor to conclude that the elasticity of demand for conversation minutes was -0.65 for intrastate calls, placing his estimate between those of the more recent studies.

Table 3.3: **Summary of price elasticities of demand for long-distance telephone calls**

Study	*Elasticity*	*t-ratio*
Duncan and Perry (1994) (United States)	-0.38 for intraLATA revenue and minutes of use with respect to toll price	4.7
Gatto, Langin-Hooper, Robinson and Tyan (1988) (United States)	-0.72 for interLATA-interstate demand for minutes of access with respect to price per minute of use	17.7
Madden, Bloch and Hensher (1993) (Australia)	-0.53 for number of minutes in the time-distance calling band 'Day 30-100 km' with respect to cents per minute	1.2
	-1.01 for number of minutes in the time-distance calling band 'Economy over 800 km' with respect to cents per minute	not available
Train (1993) (United States)	-0.42 for intraLATA minutes with respect to price per minute of use	6.0
	-0.34 for number of intraLATA calls with respect to price per minute of use	
BTCE (1991) (Australia)	-0.93 for number of domestic long-distance calls with respect to the long-distance tariff rate	6.2
Martines-Filho and Mayo (1993) (United States)	-1.05 to -1.55 (depending on parameter structure) for number of calls with respect to price paid for a call of average duration	4.9 to 21.5 depending on parameter structure
Appelbe, Snihur, Dineen, Farnes and Giordano (1988) (Canada)	-0.21 for full-rate, short-haul minutes with respect to price per minute	2.5
	-0.48 for full-rate, long-haul minutes with respect to price per minute	5.3
	-0.39 for discount-rate, short-haul minutes with respect to price per minute	6.6
	-0.49 for discount-rate, long-haul minutes with respect to price per minute	5.7

The demand elasticities for interLATA-interstate calls were generally found to be higher than for intraLATA calls. Gatto et al (1988) found the elasticity of demand for number of interLATA-interstate minutes to be -0.72 with respect to price per minute, which is comparable with that found by Taylor (1980) in his review of telecommunications demand literature of -0.75 for interstate call minutes. These levels for the price elasticity of demand for interstate calls appear to be consistent with the Australian studies: the BTCE (1991) found the elasticity of demand with respect to number of calls to be -0.93 while Madden et al (1993) estimated a demand elasticity of -1.01 for economy calls over 800 km (with respect to call minutes). The Canadian study (Appelbe et al 1988) estimated considerably lower demand elasticities for long-distance calls, between -0.21 and -0.49.

3.5 International calls

The five studies of demand for international telephone calls reviewed in detail in Appendix A all concluded that the demand for international telephone calls, both in terms of number of calls and minutes, varied negatively with price (Table 3.4). However, there were significant differences in the absolute values of the elasticities depending on the countries that calls were made between, the type of international service used to make the call, the distance the call was made over and the rate that applied at the time of the call (discount or full). The Australian estimates of the price elasticity of demand for number of calls with respect to price per minute fell between -0.37 and -1.01, while Bewley and Fiebig (1988) estimated the elasticity of demand for minutes for Australian international calls to be -1.54. From a survey of the literature, Taylor (1980) concluded the elasticity of demand for international call minutes was -0.90 with respect to price per minute, which is similar to the BTCE (1991) estimate of -1.01.

There are a number of points raised in the literature that are important for interpreting price elasticities of demand for international calls. In particular, Hackl and Westlund (1996) found that the price elasticities of demand for international calls varied significantly over time and for this reason concluded that point estimate elasticities may be misleading (see also de Fontenay and Lee 1983). Also, the BTCE (1994a) pointed out that the elasticities estimated for US-Canada traffic may not be appropriate for Australian international traffic because of the unique geographic and cultural relationship between the United States and Canada. However, the demand study of Canada-US traffic (Appelbe et al 1988) does provide some results that are likely to hold in Australia's case

— discount-rate elasticities are more elastic than full-rate elasticities and elasticities increase with the average length of haul.

Table 3.4: **Summary of price elasticities of demand for international telephone calls**

Study	*Elasticity*	*t-ratio*
Hackl and Westlund (1996) (Sweden)	-0.07 for thousands of minutes from Sweden to Germany with respect to price per minute	7.3
	-1.38 for thousands of minutes from Sweden to the UK with respect to price per minute	8.2
	-2.05 for thousands of minutes from Sweden to the US with respect to price per minute	6.7
Acton and Vogelsang (1992) (United States)	-0.36 for number of call minutes originating in the US with respect to price per minute from the US	3.9
	-0.49 for number of call minutes terminating in the US with respect to price per minute to the US	5.7
Bewley and Fiebig (1988) (Australia)	-0.37 for long-run, long-haul number of calls with respect to price per minute	3.5
	-1.54 for long-run, long-haul minutes with respect to price per minute	9.1
Appelbe, Snihur, Dineen, Farnes and Giordano (1988) (Canada)	-0.43 for full-rate, short-haul billed minutes with respect to price per minute	8.8
	-0.53 for discount-rate, long-haul billed minutes with respect to price per minute	7.9
BTCE (1991) (Australia)	-1.01 for number of calls with respect to the call charge	3.8

3.6 Broadband services

Broadband services are defined by the International Telecommunications Union (ITU) as services for which the information flow rate exceeds 2.048 megabits per second (1.544 megabits per second in the United States). The ITU definition suggests that voice and low speed data transmissions are narrowband services while television and high speed data transmissions are broadband services.

Only a limited number of Australian studies have attempted to estimate the demand for broadband services. This is primarily due to the lack of information available about demand for broadband services by different groups in the community. The majority of Australian broadband demand studies have been undertaken by Madden and Simpson (1996a, 1996b, 1996c, 1996d) who used household surveys in an attempt to overcome data deficiencies. The survey methods are described in Appendix A.

Madden and Simpson (1996b) found that the elasticity of demand for broadband subscription with respect to installation price ranged from -0.13 for low income households to -0.11 for high income households, and from -0.04 to -0.03 with respect to rental price (calculated at mean installation fee and rental prices). The underlying coefficient for installation price had a t-ratio of 4.9 while the coefficient for rental price had a t-ratio of 1.7.

Madden and Simpson (1996b) also estimated elasticities of demand for subscription to a range of broadband services: entertainment, education and information, transactions and communications. Table 3.5 presents some of their estimates with respect to both rental price and installation price and the corresponding t-ratios. The elasticities were measured at the mean installation fee and rental price and at the household income range of $40 000 to $49 999.

Table 3.5: **Price elasticities of demand for broadband services**

Service	*Rental price elasticities*	*Rental price t-ratio*	*Installation price elasticities*	*Installation price t-ratio*
Entertainment	-0.14	5.2	-0.15	5.1
Education and information	-0.10	2.9	-0.14	3.8
Transactions	-0.13	2.6	-0.19	2.8
Communications	-0.17	4.2	-0.17	2.8

Source: Madden and Simpson (1996b)

Madden and Simpson (1996a) also used the data set described above to identify households that were less likely to subscribe to broadband services and to examine whether there is a systematic link between subscription interest and commonly accepted measures of social disadvantage. They found that household characteristics (including measures of social disadvantage) are strong predictors of network subscription intentions.

3.7 Summary

There is a large and growing literature on the principles of telecommunications demand and of applications of these principles to the estimation of demand for telecommunications access and services. Several features emerge from this literature.

First, demand for customer access is generally found to be highly inelastic with respect to its own price for both business and residential customers, but especially for business.

Second, a number of studies throw light on the relationship between access demand and service prices. As expected, holding constant other prices and income, reductions in service prices result in an increased demand for access.

Third, demand for services is more elastic the longer the distance of the call. The demand for local calls is very inelastic. The demand for long-distance calls is much more elastic than for local calls, and, within the long-distance call category, demand is more elastic the longer the distance. International calls have very elastic demand, in Australian studies found to be greater than one.

Fourth, demand for any given service is more inelastic for business users than for residential ones.

Fifth, demand for any given service is more inelastic in the peak than in off-peak periods.

Finally, there is an emerging literature on the demad for broadband services, but at this stage no tangible results have emerged.

4 EFFICIENT PRICING OF TELECOMMUNICATIONS SERVICES

This chapter deals with the principles of efficient pricing of telecommunications services. As a background it reviews the literature on public utility pricing in general, concentrating on the access (two-part) pricing, Ramsey-Boiteux and peak load pricing approaches. As telecommunications has its distinctive features with respect to technology, costs and demands, the relevance of the general literature to this specific industry is assessed and adjustments made to suit the circumstances of telecommunications. The issue of network externalities in telecommunications is discussed, and the chapter also includes a brief account of regulatory structures used to influence and constrain telecommunications prices.

4.1 Public utility pricing principles

The basic problem of public utility pricing

Public utilities are often characterised by average cost being in excess of marginal cost.[1] This does not automatically ensure that they are natural monopolies, or that competition is precluded. However, it does pose a fundamental dilemma for determining prices which are both efficient and consistent with cost recovery. On the one hand, pricing the use of services at marginal cost is desirable as a means of achieving economic efficiency in the sense that user valuation at the margin is equal to the addition to cost of producing the last unit. On the other hand, marginal cost pricing of use would not result in complete cost recovery and the total cost of the public utility to society would have to be met in some other manner. The public utility pricing literature has developed around reconciling this dilemma.

The standard principles on efficient public utility pricing were developed by, in particular, Ramsey (1927), Hotelling (1938), Coase (1946) and Boiteux (1956),

1 At this stage no distinction is made between short-run and long-run marginal cost. This issue is discussed later as part of the detailed application of general public utility pricing principles to telecommunications.

and have been reviewed by Berg and Tschirhart (1988), Sherman (1989) and Brown and Sibley (1986). The standard approaches to cost recovery — two-part pricing and Ramsey-Boiteux pricing — were substantially laid down by the 1950s. Two-part pricing can involve either pricing initial units of use at a higher level or levying an access charge while charging for use of the service at its marginal cost of provision. Ramsey-Boiteux pricing is a compromise, where use is charged above marginal cost but where mark-ups vary to minimise the disturbance to the pattern of consumption that would prevail if use were charged at marginal cost. These principles are discussed further below.

The techniques for determining efficient prices where there are peaks and troughs in demand over a periodic (eg daily or seasonal) cycle were developed in the 1950s and 1960s by French, British and American economists in relation to the electricity industry. While there have been some advances since, Williamson's 1966 paper is a clear exposition of the principles of efficient peak load pricing and capacity determination. These principles, which are applicable whether natural monopoly is present or not, are also discussed further below.

Marginal cost pricing combined with direct subsidy

Hotelling (1938) emphasised the desirable efficiency properties of marginal cost pricing, rejecting the use of averaging of costs for the purposes of determining prices. As he put it (p. 284) 'that "every tub must stand on its own bottom", and that therefore the products of every industry must be sold at prices so high as to cover not only marginal costs but also all the fixed costs ... will ... be seen to be inconsistent with the maximum of social efficiency.' Hotelling's suggestion was to price use at marginal cost and cover all remaining costs from a subsidy funded by lump-sum or other non-distorting taxation.

One criticism of Hotelling's solution is that non-distorting taxes are not usually available. All major taxes result in an excess burden or deadweight loss. Contrary to Hotelling's belief, it may be more efficient to seek cost recovery directly from the industry's customers.

A second criticism of Hotelling came from Coase (1946), who suggested that the external funding of the deficit could result in the maintenance of an activity for which the total value to users was less than its total cost to society to produce. Consider a situation where average cost is greater than willingness to pay (demand price) at all levels of output, so that there is no guarantee that the total value to users is at least equal to the total cost to society of providing that output. This service would not exist if cost recovery had to be achieved by a system of user charges, and in some circumstances this would be the efficient outcome. However, Hotelling's solution would allow the maintenance of such activities worth less to society than their cost.

These criticisms directed attention towards the desirability of achieving cost recovery from users.

Two-part pricing

In principle, a properly designed multi-part tariff is the only way of achieving cost recovery without causing any inefficiency from disturbing the equality of price and marginal cost. This approach, initially advocated by Coase as part of his response to Hotelling, is usually discussed in relation to a two-part pricing arrangement. Either a block of initial units is charged at above marginal cost and the rest at marginal cost, or an access fee is charged for the right to consume units at marginal cost. Thus, this marginal use, and perhaps all use, is priced at marginal cost, while users are also required to contribute to remaining costs on some basis other than use.

For a completely efficient outcome, non-use related contributions would have to be allocated so as to satisfy two conditions. First, the aggregate of all individual contributions would have to be sufficient to cover all costs not met by marginal cost pricing. Second, individuals would have to contribute so that each paid no more than his or her economic surplus (excess of total willingness to pay over the amount actually paid) from consuming at the marginal cost price. Thus, nobody wanting to use some of the service at a marginal cost price should be denied access to the service.

While it may be possible to satisfy the first condition with an equal contribution from all users, this scheme is unlikely to satisfy the second condition. The surplus of users could vary greatly across the population, so that an equal contribution might exceed the surplus of some. However, determining individual surpluses as a basis for setting non-uniform contributions is difficult, if not impossible, to achieve in practice.

Ramsey-Boiteux pricing

Ramsey (1927) set out to solve the problem of how to raise a given amount of revenue from a set of commodity taxes with the least cost to overall economic efficiency. He found that this would be achieved by setting the tax rates on the different commodities so that they varied inversely with each commodity's own-price elasticity of demand. The marginal deadweight loss from each tax would be equalised under Ramsey's rule. Actual rates of tax on each commodity would depend on how much revenue needed to be raised.

Ramsey's idea was rediscovered by Boiteux (1956) in the context of public utility pricing. The aim in this case is to cover all variable and non-variable costs through one-part tariffs on different services, with the least overall cost to economic efficiency. As in the taxation solution, mark-ups on marginal costs for different services (or different customers) must vary inversely with their own-price elasticity of demand. The Ramsey-Boiteux rule received little attention until given prominence by Baumol and Bradford (1970) in their paper on 'optimal departures from marginal cost pricing'.

Effectively prices would have to be set across services (or users) so that the product of the mark-up on marginal cost and the own-price elasticity of demand was the same in each. In the case of two services, this means that the ratio of the mark-ups on marginal cost would be set equal to the inverse ratio of demand elasticities.[2]

Baumol (1995, fn. 5 p. 261) summarises the Ramsey-Boiteux rule as one that 'produces an optimal compromise between the requirement that the regulated firm be able to earn a fair rate of return ... and the requirement that the prices be those that most effectively promote economic efficiency.'

Peak load pricing

Public utility pricing principles are also relevant to managing cyclical and seasonal variations in demand. The peak load pricing literature determines efficient prices across the cycle and provides guidance on the efficient level of capacity. This literature was developed by French, British and American economists in the 1950s and early 1960s. The literature has been reviewed by Sherman (1989) and Crew, Fernando and Kleindorfer (1995).

The marginal cost of using a congestible facility will increase as use of that facility nears capacity. The increasing cost will manifest itself through congestion costs on other users or through the cost of dedicated capacity to relieve the congestion that would otherwise occur. Periodic demands should be charged at periodic marginal cost, giving rise to higher prices in the peak than in the off-peak periods. If marginal cost prices do not result in all costs being covered, one or a combination of the procedures for cost recovery considered earlier (two-part or Ramsey-Boiteux pricing) would be required.

The period-specific demands also provide the basis for determining whether it is efficient to vary the capacity of the facility. The demand-for-capacity

2 Where demands for the products are interdependent, a more complex formula involving 'super-elasticities' must be applied. These super-elasticities take into account both own-price and cross-price elasticities of demand.

schedule is constructed by aggregating 'net' sub-period demands for use after weighting each one by the proportion of the cycle over which it prevails. If, at the existing level of capacity, this schedule lies above the long-run marginal cost of expanding capacity, then capacity should be expanded until demand-for-capacity and long-run marginal cost are equal.

In this context 'long-run marginal cost' is the annualised per unit cost of expanding capacity. This is determined by finding the amount which amortises the investment over its expected life (evaluated at the opportunity cost rate of return), divided by the number of minutes of peak capacity made available by the expansion. In effect it is the average cost of capacity expansion. When capacity is optimal, prices always equal short-run marginal cost, but also 'on average' equal long-run marginal cost.

Where capacity is 'lumpy', adjustments have to be made in discrete jumps. Where the demand-for-capacity price rises above the efficient level determined for existing capacity, this would not immediately precipitate a capacity adjustment. Existing capacity would have to be rationed by raising the price in line with short-run marginal cost until such time as the present value of the users' surplus that would be generated by the minimum possible capacity expansion is equal to the capital cost of that expansion.

The higher price necessary to ration existing capacity would have to be paid by all users; not just those that are the 'straws that break the camel's back'. For efficient use, the price has to send the same signal to all users. Similarly, the cost of the capacity expansion would have to be allocated over all users. As argued by Hotelling (1938, p. 304), 'when a train is completely filled, and has all the cars it can haul, the marginal cost of carrying an extra passenger is the cost of running another train ... To avoid a sharp increase in rates at the time the train is filled, an averaging process is needed in the computation of rates ...'

4.2 Efficiency and cost recovery in telecommunications pricing

Production facilities and services

The technology for producing telecommunications services was described in Chapter 1. The production of telecommunications services requires use of a number of production facilities; principally the CAN, the LEN and the long-distance network. There is also an overhead infrastructure that is not involved directly in the production of any particular services. Basic carriage services are local calls, long-distance calls and international calls. All services require use of the CAN facility. Local calls use the CAN and the LEN. Long-distance calls use the CAN, the LEN and the long-distance network. International calls require use of the CAN, the LEN, (perhaps) the long-distance network and a gateway into the international network. Value-added services require specific facilities plus one or more of the basic facilities.

Categories of costs in telecommunications

Whereas the public utility pricing literature identifies 'fixed costs' and (short-run or long-run) 'marginal costs', in telecommunications there are broadly three levels of costs.

First, there are specific operating costs that vary in the short run with the level of output produced. The short run is that conceptual time period within which capacity cannot be changed. In modern telecommunications systems operating within capacity, marginal costs can be very low, but as capacity is approached, they can be substantial. The marginal costs arise either in the form of congestion externalities on other users, or via the cost of dedicated equipment installed to meet peak demand.

Second, there are costs which are fixed in the short run but can be attributed to a particular function. For example, capital equipment for switching and inter-exchange carriage of traffic (which constitutes the local exchange network or LEN) is dedicated to the carriage of local traffic (ie local calls and reticulation of higher level national and international calls).

Third, there are unallocable overheads — 'head office costs' — which cannot be attributed to any particular service. Baumol (1995, p. 278) claims that in relation to British Telecom 'a substantial proportion of BT costs (... 80 to 85 per cent ...) seem to be separable and causally attributable to the individual services responsible.'

Broad approaches to telecommunications pricing

A charging system that was based on pricing use at short-run marginal cost would generate revenues insufficient to achieve overall cost recovery. The resulting deficit — which could be the vast majority of total costs — would have to be made up by access charges.

An intermediate approach is to base prices on a version of 'long-run marginal cost', defined as the cost (on a per unit basis) of keeping a particular facility 'alive and well' in the long run. This can be proxied by average total cost of that facility (including operating costs, depreciation and a normal return on capital), expressed per minute of its use. The average total cost of an existing facility is likely to be similar to the long-run marginal cost of capacity expansion where shared costs are unimportant and where the expansion uses the same technology as the existing system. However, it is unlikely that networks would be replaced with existing technology if lower cost technologies were available. For this reason, the average total cost of a call may overstate its true long-run marginal cost.

This pricing scheme will result in the recovery of all allocable costs, but will not generate revenues sufficient to cover unallocable 'overhead' costs. This means that pricing of at least one facility will have to exceed its long-run marginal cost and/or access charges will have to be levied. These options are canvassed in the discussion of pricing different facilities that follows.

Pricing the customer access network

The costs of providing customer access to the telecommunications network are (in the absence of relevant externalities) efficiently charged to subscribers. Hazlewood (1968, p. 242) identified these as costs which are

> directly allocable to the individual subscriber, but which are independent of the number of calls he makes. These 'customer costs' consist of capital cost, converted to an annual basis, of the subscriber's telephone, the line connecting him to the exchange and the terminating equipment at the exchange, together with the cost of meter reading and of rendering regular accounts. A fixed charge per period of time is the desirable way to cover this cost item.

Under the intermediate approach, the charge for subscriber access should reflect the long-run marginal cost of providing access. While the cost of adding another subscriber in the short run in an area where the CAN is established may be quite low, pricing at this level will not result in sufficient revenue to sustain the CAN. From the long-run perspective, efficiency requires that subscribers meet the long-run costs of access. Essentially this means that, on average, access charges should reflect the average total cost.

The average costs of providing access vary according to factors such as distance from the exchange and density of subscription in the locality. It is desirable on standard efficiency grounds that CAN charges reflect the specific costs of providing access. However, in practice some form of averaging will be justified on the basis that the costs of differentiating charges will exceed the benefits.

In addition to recouping the full costs of access, the CAN is also a potential source of efficient contribution to unallocable overheads. Access demands, especially those of business subscribers, are highly inelastic with respect to the access price charged. This means that the deadweight loss from raising substantial amounts of revenue to achieve cost recovery would be low, (although the Ramsey-Boiteux rule would dictate equality of the marginal deadweight loss from the deviations of prices for different telecommunications services from their marginal costs).

Pricing use of the local exchange network

The LEN is a set of dedicated equipment for the purposes of switching and inter-exchange carriage of local calls and reticulating higher level telecommunications traffic. In modern systems the costs of the LEN are substantially fixed in the short run, with relatively low operating costs. Ignoring peak load considerations (see below), pricing according to short-run marginal cost would result in recovery of only a small proportion of total costs of local carriage. The costs of the LEN not covered by short-run marginal cost charges on local use could be met by charges not related to use, or by charges on the use of other services.[3]

The concept of 'short-run marginal cost' has to be modified for operation at peak loads. Peak traffic costs can arise in the form of a congestion externality on other users. Alternatively there may be an (annualised) cost of equipment established solely to cater for peak loads. Where congestion occurs, it would be efficient to charge users a price inclusive of a Pigouvian 'tax' reflecting the externality cost on other users. Where dedicated peak load equipment is installed, according to Hazlewood (1968, p. 245), the cost of this equipment 'should be a charge on peak traffic' or (Kahn and Shew 1987, p. 226) these 'capacity costs ... are traffic-sensitive, because they are marginally attributable to usage, and may be regarded as the long-run marginal equivalent of the congestion costs that they mitigate.'

An alternative approach to short-run marginal cost pricing would be to take a longer-run approach, and base use charges on long-run marginal cost; where this is defined as the annualised cost of preserving the local network in perpetuity expressed in terms of units of use. Average total cost is an upper bound proxy for long-run marginal cost defined in this way.

In addition to covering cost in this way, local use could also contribute to unallocable overheads, again according to the Ramsey-Boiteux rule of equating marginal deadweight losses from divergences of prices from (long-run)

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3 Hazlewood (1968, pp. 242–3) would retrieve these from an access charge: 'costs, while varying with the number of subscribers to be served, are not costs of equipment reserved for the sole use of a particular subscriber — ... switching equipment, ... main duct and pole routes ... These indivisible costs should be allocated as a fixed charge proportional to 'consumers' surplus', or on the principle of 'what the traffic will bear'.'

marginal costs on the various services. As local use has a low elasticity of demand, it could sustain a high mark-up at a low deadweight loss.

Pricing long-distance calls

The long-distance network is a set of dedicated equipment for the purposes of carrying domestic long-distance calls between local exchange areas and for carrying international calls from local exchange areas to international gateway exchanges. Within capacity, the costs of the long-distance network are substantially fixed in the short run, with relatively low operating costs. Consequently, pricing according to short-run marginal cost would result in recovery of only a small proportion of the total costs of long-distance carriage. The costs of the long-distance network not covered by short-run marginal cost charges on long-distance calls could be met by charges not related to use, or by charges on other services.

Alternatively, a longer-run approach would base these charges on long-run marginal cost; where this is defined as the annualised cost of preserving the long-distance network in perpetuity expressed in terms of units of use. As in the case of local use, average total cost is a reasonable upper bound proxy for long-run marginal cost defined in this way. In addition to covering long-distance costs, long-distance calls have to meet the cost of using the LEN for local reticulation. Again, this could be based on long-run marginal cost.

The pricing of long-distance use could also contribute to unallocable overheads. If this were on the basis of the Ramsey-Boiteux rule of equating marginal deadweight losses from divergences of prices from (long-run) marginal costs on the various services, there would be a relatively small mark-up. Long-distance use has a relatively high elasticity of demand, making it unable to sustain a high mark-up without a large deadweight loss.

Pricing international calls

The costs of international carriage are largely outside the control of domestic telecommunications providers. An outgoing international call requires local and (where applicable) long-distance domestic carriage, which are under control of domestic operators. It also requires international carriage, where the sending operator is responsible for the cost of the getting it half way to its foreign destination (a 'half-circuit'). The domestic operator in the receiving country is responsible for the other half of the international carriage plus the cost of domestic carriage in the receiving country.

Carriers in sending and receiving countries agree on accounting rates for the charging of international calls. These are the same (in local currency terms) in both countries. The telecommunications carrier in the country sending the call pays half of the accounting rate to the carrier in the receiving country. This amount is known as the settlement rate. The carrier in the country sending the call can charge users whatever it likes above or below the accounting rate (within regulations, if any), and this price is known as the collection rate.

In principle, efficient pricing of international calls would be based on the sum of marginal costs of carriage at each stage. Pricing at long-run marginal cost would ensure cost recovery narrowly defined, but there would be no contribution to unallocable overheads. High demand elasticity estimates suggest that international calls would not be able to sustain a large mark-up on long-run marginal cost without substantial damage to economic efficiency.

Efficient pricing of value-added services

The services offered by the simple traditional telephone system — as analysed in the early 1950s by Hazlewood (1968) — were local, trunk and international calls. These are now known as 'basic carriage services'. Not only have these changed markedly in composition (long-distance and international calls combined in Australia now account for more revenue than local calls and customer access combined), but there has been a proliferation of value-added services (VAS) that combine product-specific telecommunications hardware with the basic telecommunications network to offer enhanced services. These VAS include mobile cellular services, the Internet, paging, and message services. Mobile services in Australia now account for more revenue for Telstra than any of the basic carriage services individually (BZW Australia 1996, p. 60).

These new services present interesting pricing issues, some of which are covered in Chapter 5. First, there is the issue of how VAS should pay for their use of basic production facilities like the LEN. For example, all mobile calls (even those that are mobile to mobile) use the fixed network for part of the transmission (see Chapter 1). For efficiency, any VAS using the network should efficiently meet the long-run marginal cost of that use.

Second, there is a need to determine their share in funding the unallocable costs of running the jointly-consumed basic telecommunications network. As usual, for efficiency, this would be based on the relative efficiency of attaining a contribution from this source compared with other potential sources. This is determined primarily by the elasticity of demand.

Third, to the extent that VAS are substitutes for traditional services, this has implications for the pricing of telecommunications services. For example, many if not most calls from mobiles have some degree of substitutability with calls from fixed-wire services. Under Harberger's (1971) general equilibrium efficiency analysis, the reduction or increase in demand for substitute services for which price exceeds marginal cost will have efficiency implications in those markets.

4.3 Importance of network externalities in telecommunications

Telecommunications is a network industry with the characteristics of a club. Both the cost of, and the value of, club membership depend on the number of subscribers. Access to the network is the telecommunications equivalent of club membership. A new member of the club provides benefits to existing members who can now call an additional subscriber. This means the private value of membership will differ from the social value. The existence of such 'network externalities' gives rise to a prima facie case for subsidisation of new membership.

This externality is likely to be important in the early years of establishing a network where the value of a new subscriber may be expected to be highly valued by existing subscribers. For example, this is likely to be the case currently with e-mail and the Internet club.

However, the consensus in the literature is that the network externality is no longer an important issue for basic telecommunications services. For example, as noted by Mitchell and Vogelsang (1991, p. 55) the 'importance of network externalities for ... plain old telephone service ... has been reduced as penetration rates approach 100 percent of all households ...'. Similarly, Yarrow (1996, p. 75) concludes that 'the network externalities case for regulatory intervention to promote universal service is far from compelling ... particularly in developed telecommunications systems ...'. De Fontenay and Lee (1983) and Breslaw (1985) note that in mature networks, existing subscribers may be willing to pay more to remain subscribers because of the externality, but the addition of a new subscriber is unlikely to make the system more valuable to non-subscribers or induce them to subscribe.

It is difficult to see that the network externality could justify an access subsidy for all users, even in a young network. Access is essentially a zero/one decision — either you do subscribe or you do not. For those households with a willingness to pay for access in excess of the full cost of provision, they will choose to subscribe anyway at a price equal to full cost, and payment of an access subsidy would not alter their behaviour. For efficiency, the subsidy would have to be targeted at those households which have a willingness to pay for access less than the full cost of access, and therefore, would not otherwise subscribe. As noted in Chapter 3, the empirical studies suggest that businesses have a highly inelastic demand for access and subsidisation is highly unlikely to be necessary. Similarly, households as a group have very inelastic demands, although a higher elasticity appears to be associated with particular household characteristics.

4.4 Regulation of telecommunicationspricing

Traditionally, telecommunications providers in many countries have not been completely free to set their prices. Governments have intervened to control possible abuse of monopoly power, and have regulated telecommunications pricing in pursuit of social objectives, including high telephone penetration rates. Currently there is a tendency to loosen controls in the face of increasing competition and a trend towards more direct means of advancing social goals.

Uniform geographical pricing and community service obligations

In many countries, the telecommunications service traditionally has had a statutory obligation to provide 'basic services' at a uniform geographical price in spite of substantial cost differences. This is sometimes known as a universal service obligation (USO). Additionally, there has often been an obligation to provide concessional prices to some users — commonly known as a community service obligation (CSO). The cost of these obligations is effectively met by a 'tax' component added to other prices, and the mechanism is sometimes called 'cross-subsidy'. These regulations introduce an inefficient element into the pricing structure.

In assessing these arrangements, care needs to be taken in defining 'subsidy'. The technical literature has tended to accept Faulhaber's (1975) definition involving an incremental cost test. A service is not subsidised if the revenues generated exceed the long-run avoidable incremental cost. Cross-subsidy is absent when the 'stand-alone test' is also satisfied, and no service produces revenue in excess of the cost of producing it outside the multi-product organisation (Mitchell and Vogelsang 1991, Ch. 6).

Price capping regulations

Neither natural nor unnatural monopolists have an incentive to price efficiently if unregulated. While profit maximising behaviour will lead them to price in the Ramsey-Boiteux pattern, they will exceed those prices compatible with cost recovery in the pursuit of monopoly profits. This gives rise to a prima facie case for pricing regulation.

The approach to the regulation of telecommunications pricing has changed markedly in the last ten to fifteen years. One approach was the direct regulation of particular prices (eg Britain and Australia) which was informationally-demanding and often poorly-executed. Another method was rate-of-return regulation; mainly used in the United States and associated with inefficient input choices (Mitchell and Vogelsang 1991, pp. 65, 150). The current trend is towards a form of 'price capping'.

In practical terms, price capping regulation was devised for British telecommunications (Littlechild 1983) and is known there as 'RPI − X', where the RPI is the retail (or consumer) price index. It is loosely consistent with a theoretical foundation established by Vogelsang and Finsinger (1979). The idea is to reduce excess pricing overall while giving the telecommunications operator the incentive and ability to 'rebalance' pricing in the direction of the Ramsey-Boiteux pattern.

Under this regulation, the telecommunications operator is obliged to raise the revenue weighted average of prices of services in the capped basket by no more than the consumer price index less some specified percentage, 'X'. X can be interpreted as an allowance for the cost reductions flowing from technological change and efficiencies from reorganisation, and/or a factor reflecting an objective to remove above-normal profits.

The idea of price capping is to allow the multiple service provider gradually to move its prices to the Ramsey-Boiteux configuration consistent with the coverage of overheads and the allowed level of economic profit. While keeping within the cap, profit maximisation will induce the firm to reduce prices that are 'too high' and increase those that are 'too low' (both in the sense of marginal profitability), until marginal profitability is the same on all services. But equation of marginal profitability also has the effect of equating marginal deadweight loss, and therefore, minimises total deadweight loss for the given surplus above total variable cost.

4.5 Conclusion

The two dominant approaches to efficient public utility pricing are two-part pricing and Ramsey-Boiteux pricing. In the circumstances of telecommunications, where traffic-sensitive costs are very low relative to 'fixed' costs, the two-part pricing approach would result in extremely low use prices (except perhaps at peak load) and very high access charges. On the other hand, application of the Ramsey-Boiteux principle would result in very high prices for use, in some cases with very large mark-ups on short-run marginal costs. An intermediate solution between these extremes is both defensible in principle and pragmatic in the circumstances of typical existing pricing structures.

This approach involves recognising three levels of costs:

- specific operating costs that vary in the short run with the level of output produced;
- costs which are fixed in the short run but can be attributed to a particular function (eg long-distance carriage); and
- unallocable overheads — 'head office costs' — which cannot be attributed to any particular service.

Under the intermediate pricing solution, subscriber access charges would meet the full costs of providing access, and provide some contribution to unallocable overheads. Pricing of the functional areas — principally the local exchange network, the long-distance network and various value-added networks (including mobile) — would be based on long-run marginal costs, defined in terms of average costs of preserving the network's capacity in the long run. Any necessary deviations of access or use prices from relevant (long-run marginal) costs in order to meet unallocable costs would follow the Ramsey-Boiteux principle. Long-run marginal cost is a defensible benchmark for efficiency analysis where a long run perspective of efficiency is taken.

Typical pricing structures — like those in Australia — have subscriber access prices below levels consistent with cost recovery and prices for use of different services exceeding long-run marginal cost. These deviations from relevant cost are not consistent with the Ramsey-Boiteux inverse-elasticity rule. The subsidies for access cannot be justified on the basis of network externalities in mature networks with very high penetration rates. In the absence of special constraints on particular prices, general price capping regulation (CPI – X) can provide some constraint on the overall level of prices while allowing the telecommunications provider to 'rebalance' individual prices in the direction of greater efficiency according to Ramsey-Boiteux principles.

5 COMPETITION IN BASIC TELECOMMUNICATIONS SERVICES

This chapter examines the principles underlying determination of the interconnect price paid by new entrants for access to the incumbent's network. Many countries have introduced competition into the provision of basic telecommunications services. The objective has been to achieve efficiency gains in the form of more efficient pricing, greater technical efficiency and dynamic efficiencies. In all these countries, the new entrant has not been expected to establish its own complete network, and has been granted regulated access to the incumbent's network, particularly for the reticulation of local calls. The principles governing the selection of the access price are crucial. An excessively high price may deter socially-desirable entry of users, or alternatively encourage wasteful duplication. A price too low could deter efficient entry of providers and even lead to insolvency of the incumbent. Explanation of the principles underlying determination of the interconnect price is one of the principal concerns of this chapter. In addition, it considers the institutional structure surrounding the provision of access.

5.1 Reasons for network competition

The traditional view of the telecommunications industry was one where natural monopoly elements precluded competition in the provision of the network and basic network services. Competition was prevented by statute. However, beginning with the United States in the 1970s, the trend in OECD countries has been to allow competition in the provision of the network and basic carriage services. This has occurred in Britain, Japan, New Zealand, Australia and Canada, among others. The motive for allowing network competition is the promotion of greater efficiency — allocational, technical and dynamic.

Allocational efficiency is affected by pricing. Statutory monopoly has sometimes been associated with the use of monopoly power to maintain prices well above marginal costs of provision, leading to above-normal profits and deadweight efficiency losses. Further, contributions to unallocable overheads have often been achieved in very inefficient ways, providing the potential for efficiency gains from substantial 'rebalancing' of pricing structures.

Technical efficiency refers to the amount of inputs it takes to produce a given level of outputs. Again, statutory monopoly has often coincided with excessive input use in producing outputs, leading to excessive costs of provision. For example, the Bureau of Industry Economics in its telecommunications benchmarking studies (BIE 1995a and 1995b) suggested that Australia's technical performance was some distance from international best practice (for comparable countries) on a number of indicators. A substantial gap has been acknowledged by Telstra's CEO, Frank Blount, who is quoted as saying that 'We make no secret that we are 35 per cent from where we ought to be' ('Blount and to the point on sale', *Australian Financial Review*, 28 June 1996).

Dynamic efficiency relates to the rate of adoption of new technologies in network switching and carriage, and of new services. While there is debate about whether monopoly is or is not conducive to dynamic efficiency, governments introducing competition in network provision have claimed gains in the form of dynamic efficiency from market liberalisation.

5.2 Network competition through interconnection to the essential facility

In all countries where network competition involving the provision of basic carriage services has been introduced, the entrant has not been expected to reproduce the entire network of the incumbent. In particular, it has been recognised that the local network would be costly to reproduce and that the new carrier will likely enter (at least initially) by establishing its own long-distance network, relying on the existing firm for local reticulation of its calls through the incumbent's local network.

The rationale for this approach to network competition is based on the idea, first, that natural monopoly in the local network makes it an 'essential facility' or 'bottleneck facility' for successful entry, and second, that the supplier of access must be prevented from exercising its monopoly power. The belief that the local network is a natural monopoly was considered in Chapter 2.

Interconnection is usually subject to regulation by an independent regulator. Although each has its distinguishing features, this has broadly been the approach in the United States, the United Kingdom, Japan, Australia and New Zealand.

In the United States and Japan, the powers of existing regulatory authorities were extended to cover access pricing. In the United Kingdom and Australia, a new regulatory body was established. In New Zealand, new participants were given the protection of the anti-monopoly provisions of the Commerce Act.

5.3 Interconnection access pricing principles

The outcome of allowing network competition depends partly on the price at which the entrant is allowed to interconnect with the existing carrier's local network. Suggestions have ranged from long-run marginal cost of preserving the network as a lower bound, to Baumol and Willig's efficient component pricing rule (ECPR) as an upper bound (Baumol and Sidak 1994, 1995, Baumol 1995). The ECPR is long-run marginal cost plus the opportunity cost to the incumbent in terms of forgone super-normal profit and contribution to overheads.

The overall outcome for 'retail' prices depends not only on the access price charged to the entrants, but also on the interaction of rivals in the product market(s). These possibilities range from complete collusion, thereby maintaining monopoly pricing in product markets, to 'Bertrand' competition driving product prices down to long-run marginal cost.

If the access price is set 'too low', the entrant may be excessively discouraged from establishing its own infrastructure and the incumbent will not cover its incremental costs of providing access on a continuing basis. In the extreme, the supplier of access could be rendered financially non-viable. One component of the loss arises from being forced to supply access to the entrant at below its long-run marginal cost of provision. A second loss may arise from not having the ability to retrieve overheads from long-distance call revenues. This would occur if the sum of the entrant's access charges and own per unit long-distance transmission costs were below the incumbent's long-run cost of local reticulation plus its own per-unit long-distance cost.

The typical circumstance of network competition by interconnection is one where domestic long-distance prices are substantially above their long-run incremental cost of provision, and part of the motivation for allowing entry is to compete long-distance prices down. Where the gap between price and long-run marginal cost is large, there is substantial scope for lowering prices and profitable operation of both the existing and new carrier(s), although the original carrier typically will experience a reduction in contribution to unallocable overheads and profit.

In its most basic exposition, the Baumol-Willig rule protects the existing firm's contribution to unallocable overheads and profits by charging long-run marginal cost plus the full opportunity cost (Baumol and Sidak 1994, p. 94). Under an extreme interpretation, this implies that the entrant would be charged for use of the local network at the full existing long-distance price minus the incumbent's average cost of providing the long-distance segment. This would limit the potential fall in the long-distance price to the difference (if any) between the incumbent's and the entrant's unit costs on the long-distance segment.

In response to criticism (eg Tye 1994, p. 210), Baumol and Sidak (1995, p. 178) introduced a 'second efficiency requirement that, in addition to the efficient component-pricing rule, final product prices must be constrained by market forces or regulation so as to preclude monopoly profits.' However — as explained below — this does not ensure that an entrant with lower costs on the long-distance component could enter profitably.

Baumol and his co-authors consistently use the example of a railroad with a two-stage production process of a single output operated by the incumbent.[1] There is an incremental cost on each of the A-B and B-C production stages plus an overhead which (implicitly) applies to the production of the entire service. The potential entrant would operate its own B-C segment and pay an access charge for use of the incumbent's A-B segment. Under the ECPR, the access charge for A-B is the incremental cost of the segment plus the 'opportunity cost' of the incumbent's lost contribution to the overhead.

Consistent with the idea of contestability, if entry occurred the entrant would force out the incumbent and become the sole supplier of the service. The incumbent's only role would be to carry the entrant's traffic on the A-B segment of the production process.

In Baumol's treatments there is never any mention of the entrant having any overhead costs. Given that the entrant will become the supplier of the service, it is reasonable to expect that it would have an unattributable overhead cost. Conversely, the incumbent in its new role as supplier of a component would no longer have any overheads as these relate to the supply of the service, not to the operation of a production segment.

Recognition of the role of overheads leads to the possibility that a more cost-efficient operator could not enter under the Baumol-Willig rule. Where a potential entrant has overheads no higher than those of the incumbent and where its overheads are in excess of its cost advantage on the B-C segment, it would be socially advantageous for it to enter. However, it could not profitably enter under the ECPR.

The railroad example used to illustrate the Baumol-Willig rule does not capture many of the features of the particular industry — telecommunications — to which the rule is usually applied. There are three main differences between the railroad example and the circumstances of telecommunications.

[1] The discussion of the railroad example is a non-technical treatment of the analysis in Albon (1994).

First, in telecommunications the incumbent continues to provide long-distance (A-C) service in competition with the entrant. Entrants often develop niche markets, resulting in an expansion of total traffic. Even if the notion of compensating for the loss of contribution to overheads in the access charge were accepted, only the loss of absolute market share would have to be compensated.

Second, the provision of customer access to the telecommunications network by the incumbent is, for most users, in highly inelastic demand, and provides an alternative potential charging point for the efficient recovery of overheads.

Third, in telecommunications the A-B segment is not just a production component, but also represents a separate service — local call provision. This provides another possible source of funds to cover unallocable overheads.

In conclusion, given the objectives and circumstances of network competition in telecommunications, the ECPR is an inappropriate approach. There is no clear basis for inclusion of forgone profits as an opportunity cost, while any allowance for lost contribution to unallocable overheads must be considered in view of the incumbent's other options for retrieving these costs. In this sense, the ECPR has deflected attention from the basic problem of public utility pricing — the achievement of cost recovery at the least cost to economic efficiency.

5.4 Institutional basis for the provision of access

In addition to the interconnect access price, the other important determinant of the outcome of allowing network competition is the institutional structure in which the process occurs. A key element of that institutional structure is the structure of the incumbent. The possibilities range from a completely vertically integrated incumbent subject to regulation (based on a requirement to supply accounting information) through to 'divestiture' of the local network by the incumbent.

Vertical integration with regulated access

Under this approach, the existing firm remains vertically integrated, but is subject to regulation. The case for regulation arises because, on the one hand, the incumbent supplies access to the local network in the wholesale market, and, on the other, competes with the new entrant in the provision of long-distance and international calls. The obvious possibility of conflict of interest suggests that access pricing would have to be regulated by an independent arbiter, and that the regulator would require the incumbent to supply it with product-based financial statements.

Consider first why the incumbent's dual role as a supplier of access and a competitor with those gaining access may lead to a conflict of interest. While the existing firm benefits directly from supplying access as long as the price it receives exceeds the full cost of provision, it loses to the extent that it loses profitable business for the final product. This is likely to be a typical situation in those instances where it is forced to allow (rather than volunteers) access to a competitor.

In New Zealand, for example, a number of commentators have criticised the failure to divest the natural monopoly part(s) of New Zealand Telecom prior to its privatisation and exposure to competition. According to Ahdar (1995, p. 116), the 'failure to separate the monopolist from its essential facility prior to privatisation ... is a recipe for trouble.' Similarly, in the United Kingdom, Armstrong and Vickers (1995, p. 289) argue that '[v]ertical separation has the advantage that it removes the incentive for the firm in the natural monopoly activity to behave anti-competitively towards rivals in the potentially competitive activity' and that 'it is best to carry out any restructuring ... *before* privatization.'

The remedial approach taken in both the United Kingdom and Australia is misleadingly called 'accounting separation'. Australia's AUSTEL requires Telstra to supply confidential product-based financial statements through the Chart of Accounts (COA) and Cost Allocation Manual (CAM). The COA/CAM statements assist AUSTEL in arbitrating over disputes involving interconnection into Telstra's local network.

As a general approach, requirements for accounting information reduces the scope for anti-competitive conduct of this kind, but 'it treats the symptoms of the problem and does not change the incentives' (IC 1996, p. 87). That is, there is still an incentive to behave in an anti-competitive manner, but less ability to get away with it.

Further, this structure may be conducive to collusive behaviour between the incumbent and its rival, supporting monopoly pricing. As noted by the Industry Commission (1995)

> Where the access provider is vertically-integrated, the commercial negotiations ... provide a venue for it and its potential competitors to discuss pricing and output, activities that would normally be deemed anti-competitive. (p. 37)

Any tendency to collusion on final product prices is likely to be encouraged by access arrangements which bring the parties together for the purposes of determining interconnect agreements.

There is a third potential problem with the vertically integrated structure, especially in very large multi-product organisations without division into focused semi-autonomous businesses. This structure does not form a good basis for the introduction of a coherent incentive system. Establishment of the link between effort and achievement requires a clear focus on objectives and sound accounting information on performance in particular areas.

Arms-length business units under common ownership

An alternative approach would be to require the formation of arms-length business divisions within the incumbent firm. These would act as profit centres, with economic pricing of transactions for both internal and external transactions. Clear commercial objectives would be established for the different businesses. Responsibility for operation of the local network would lie with one of these businesses. It would supply access and local switching on a commercial basis to other parts of the firm and to other carriers and service providers.

This would go some way towards solving all three problems identified with the accounting information approach, especially the third. However, while the dominant firm remained under a common board of management, there could still be an incentive both to thwart and to collude with the opposition where this was in the commercial interests of the entire organisation.

Vertical separation

At the other extreme (to vertical integration with an accounting information requirement) is the policy of vertical separation or divestiture. In the United States, the dominant carrier was forced to divest itself of its regional operating companies on the basis that this would remove any conflict of interest between competitive long-distance operations and the supply of access to the local network. Regulation — in this case by the Federal Communications Commission — is to prevent the provider of access from exercising monopoly power to the detriment of all those interconnecting, rather than preventing the access provider from acting against the interests of its product market rival(s). This model has not been followed in other countries introducing network competition.

King and Maddock (1996a, pp. 88–91 and Ch. 8) express some reservations about vertical separation of public utilities in general, including the loss of economies of scope. The usual justification for a vertically integrated structure lies in the belief that there are economies of scope from having the different functions within a single organisation. Coase's (1937) theory of the firm explains the existence of firms (as opposed to the demander of the product organising production and making contracts with the various suppliers of productive services) in terms of reduced transaction costs. Separation of the incumbent could raise the danger of losing the 'economies of scope' that may arise from these reduced transaction costs and from the sharing of common costs.

When it comes to telecommunications, however, King and Maddock (1996b, p. 32) are of the view that 'Telstra's local call network, particularly in the central business districts of Australia's major cities, is unlikely to involve natural monopoly technology'. Since economies of scope are necessary for natural monopoly (Chapter 2), the implication is that vertical separation of the local network would not involve the loss of significant economies of scope.

King and Maddock (1996a) are also concerned about the possibility of 'double marginalisation' by the vertically separated firm. Under vertical integration the firm makes a single decision about the profit-maximising price and output in the market for retail service. Under separation, the upstream firm decides on its price for the component it supplies to the downstream firm according to its insular profit-maximising rule. The downstream firm then makes its own decision regarding the final product, taking into account the 'inflated' price at which it has been supplied the component by the upstream firm. The end result is a higher price and lower quantity than under vertical integration.

Double marginalisation requires, first, that the local network provider and the long-distance provider both have monopoly power, and, second, that there is no regulation. Neither condition is met under the circumstances of network competition observed in most countries. In relation to the first, unless the incumbent and the rival collude perfectly there will be some competition in the product market. Second, in all cases there is some regulation, usually with the regulator having access to detailed knowledge of cost structures in both local and long-distance call production.

5.5 Conclusion

In all known cases, competition in basic telecommunications services has proceeded on the basis of the rival having access to the incumbent's local network. The principles on which access is to be priced, and the institutional structure in which interconnection takes place have been the subject of intense debate. To some extent the objectives of introducing competition have not always been central in the discussion. This is particularly true of the ECPR, where its proponents have taken a narrow view of 'efficiency'. With respect to structure there is a consensus in favour of some degree of separation of the access provider, but there has been concern about the possibility of double marginalisation and forfeiture of economies of scope from divestiture involving separation of ownership. However, there is no strong evidence that either of these problems is likely.

6 INTRODUCTION TO THE POLICY ISSUES

The Australian telecommunications industry has undergone a remarkable transformation over the past two decades. The Australian Telecommunications Commission (Telecom) was formed out of a Commonwealth Government department in 1975, under full government ownership and with a statutory monopoly on the supply of telecommunications services. The pace of change has accelerated since 1989, with Telecom and its successor, Telstra, being subject to successively greater amounts of competition. Competitive pressures will increase again from 1 July 1997, when the existing duopoly ends.

There are several key regulatory and structural issues relating to the government's involvement in the telecommunications industry. Four of these are considered in detail in this study.

> *Are there still elements of natural monopoly in the local network justifying some form of regulatory control on competition in service markets?*
>
> *Are the price-capping and other pricing regulations consistent with movement to an efficient pricing structure?*
>
> *Is the existing approach to access pricing compatible with efficient capacity provision and utilisation, and efficient final product pricing?*
>
> *Is the institutional structure — including the structure of the dominant carrier — appropriate for the more competitive regime to be established from July 1997?*

6.1 Changes to Australian telecommunications since 1975

The Australian telecommunications industry has gone through a remarkable transformation in the last twenty years, since the Australian Telecommunications Commission (Telecom) was formed out of a Commonwealth Government department in 1975, under full government ownership and with a statutory monopoly on the supply of telecommunications services. The changes have broadly involved liberalisation, including:

- corporatisation, giving Telecom a more commercial focus and establishing AUSTEL, an independent regulator;
- increasing competition, first in the form of alternative suppliers of CPEs and value-added network services (VANS), and later in the network from Optus, a second licensed network carrier; and
- privatisation — the domestic satellite operator, AUSSAT, was sold to Optus, complete with a network licence.

Origins of Telecom from the PMG

Until 1975, Australian domestic telecommunications services were provided by an operating unit within a government department, the Postmaster-General's Department. The operating unit, the Australian Post Office (APO), had a complete statutory monopoly precluding virtually all activity by any private or government-owned bodies. Mail services were also operated by the APO. International telecommunications services were the exclusive province of the Overseas Telecommunications Commission (OTC), established in 1946. OTC relied on the APO for domestic reticulation of its calls.

The original 'Telecom' (initially the Australian Telecommunications Commission) resulted from the separation of the telecommunications and postal parts of the operational section of the Postmaster General's Department in 1975, and its removal from departmental operation. These changes followed the 1974 Vernon Report recommendations. Telecom remained under full government ownership and continued to have a statutory monopoly on all aspects of providing telecommunications services, including CPEs and VANS. While Telecom was subject to pricing regulation and other constraints on its operations by government, Telecom itself acted as the 'technical' regulator of the industry.

The OTC had been established in 1946 with sole responsibility for handling Australia's overseas telecommunications traffic. Domestic reticulation of that traffic was handled by the APO/Telecom. AUSSAT was formed in 1981 to own and operate Australia's communications satellite, with a 'foot print' coverage including some of Australia's near neighbours. AUSSAT's functions included broadcasting and the provision of private network services involving interconnection with Telecom's network for the origination and termination of calls.

Corporatisation and the Evans reforms

Corporatisation of the then Telecom in the late 1980s gave it a substantially more commercial focus, with much greater operational freedom, clearer objectives and a more business-like structure. However, it did not involve structural division into arms-length business units. The 1988 Ministerial Statement (Minister for Transport and Communications (G. Evans) 1988) resulted in the opening up of most CPE and VANS areas to competition, formalising a trend commenced by Telecom itself during the 1980s. Responsibility for regulation was split off from Telecom with the formation of an independent industry-specific regulator, AUSTEL.

AUSTEL commenced a form of more 'light-handed' pricing regulation based on a 'CPI – X' price cap (restricting the increase in the weighted average of a basket of telecommunications services to rise no more than the CPI less a specified percentage) with individual sub-caps on some prices. A requirement for uniform geographic pricing remained, meaning, in particular, that STD prices were based on distance and time of day, without any allowance for density or thickness of traffic on the route.

The Review of Ownership and Structural Arrangements (ROSA) reforms

The next review (ROSA) occurred during 1989–90. The report was not published, although Fanning (1992) provides a useful summary of its considerations. Some of these are covered in more detail in Chapter 7.

ROSA was concerned with the relationships between the then three carriers — Telecom, OTC and AUSSAT — and not with structural issues internal to any of the carriers. ROSA, combined with other considerations, culminated in another Ministerial Statement (Beazley 1990). The principal decisions made in this statement and around this time were as follows.

- Telecom and OTC were amalgamated. The amalgamated body was initially called the AOTC and later was named Telstra. An International Business Unit continued OTC's role within AOTC/Telstra.
- AUSSAT was 100 per cent privatised, with a full carrier licence attached to the sale.
- The issuing of this licence allowed the advent of network competition between AOTC and the second licensed carrier, with a guarantee of no new competition until 1997. The purchaser of AUSSAT, Optus Communications, was guaranteed regulated access to AOTC's local network to reticulate its calls, with AUSTEL as the regulatory body.

Optus was also licensed to operate a second mobile telecommunications service.

- A third mobile licence was allocated. This was subsequently attained by Vodafone which chose only to operate a digital mobile service. Telstra and Optus offer both digital and analogue services, although Optus buys its analogue capacity from Telstra.
- Licences were granted to various service providers (SPs) offering VANS and re-selling services purchased from AOTC.

Telstra's structure

Telecom/Telstra's structure has changed considerably in the years following the splitting of postal and telecommunications services and its removal from departmental control in 1975. It has progressively been subjected to more competition, been corporatised, and assumed more functions, partly through technological change and partly from the amalgamation with OTC. It has moved from what was still a state-based management structure to one based more on functions, and this evolution is continuing. However, Telstra still retains a largely 'integrated' organisational structure.

Telstra is divided internally into seven 'groups' and one subsidiary (BZW Australia 1996, pp. 28–31 and Telstra *Annual Report 1996*):

- Commercial and Consumer;
- Business and International (all but the smallest businesses, government business and the International Business Unit (formerly OTC));
- Retail Products and Marketing;
- Network and Technology;
- Finance and Administration;
- Regulatory and External Affairs;
- Employee Relations; and
- Telstra Multimedia Pty Ltd.

The divisions and sub-divisions do not operate separately as independent profit centres. Transactions conducted between them are not at 'arm's length', and all are ultimately responsible to the one Board of Directors.

Initial access arrangements

When network competition in telecommunications commenced, the AOTC was obliged to allow the second carrier, Optus, access to its network for the purpose of reticulating its long-distance and international calls at the local network level. Under the initial competitive regime, the local network (including the customer access network or CAN) was viewed as an 'essential facility' for the final distribution of the second carrier's long-distance and international calls. Optus initially established only its own long-distance network, relying totally on AOTC for local reticulation.

When Optus commenced its plans for entry in 1991, the two carriers could not agree on the conditions of access, and AUSTEL was instructed to report to the Minister on the conditions under which Optus would be allowed to interconnect. The interconnect agreement was determined on the basis of directly attributable incremental cost (DAIC), although AUSTEL did include some CAN costs — which are not incremental — in the determination. The price determined accorded loosely with long-run marginal cost (King and Maddock 1996a, p. 144).

AUSTEL has since developed a model of 'accounting separation' involving confidential product-based financial statements through the Chart of Accounts (COA) and Cost Allocation Manual (CAM). The COA/CAM statements assist AUSTEL in arbitrating over disputes involving interconnection into AOTC/Telstra's local network.

As Optus's and other competitors' activity has increased, Telstra's share of some markets has decreased and access agreements have become based on commercial negotiation. Commercial negotiation without regulatory backing is mandatory where Telstra loses 'dominance' in a particular market. So far this has only happened in mobiles and international, but Telstra has a strong interest in proving loss of dominance in other areas. Loss of dominance means that Telstra can offer prices other than those in published tariffs. Consequently there has been substantial attention to definitions of 'dominance'.

Optus commenced offering a local call service (based on Telstra's local network) in 1996. Subsequently, it has moved to establish its own local network in particular urban areas. This allows it to offer both pay television and local telephony services independently of Telstra.

New access arrangements

At present, AUSTEL acts as the arbitrator on access disputes. In the new Exposure Draft on post July 1 1997 legislation (Minister for Communications and the Arts 1996), where commercial negotiation fails, the Australian Competition and Consumer Commission (ACCC) — not AUSTEL — will play the arbitration role.

Under arbitration, the primary focus of the access regime is 'to promote long term interests of end users' and the criteria are supposed to give ACCC 'clear guidance'. The explicit criteria (#260) include 'the direct costs of providing access', and 'the economically efficient operation of a carriage service'. Further, the Minister may intervene with guidelines to assist the arbitration process. These will be binding and no access undertaking or agreement in existence can be incompatible with them. This power seems to give the Minister substantial discretion regarding the principles guiding arbitration and, perhaps, the power to determine prices directly.

In the meantime, there will be a substantial debate on access pricing principles. ACCC (1997) and BTCE (1997) have produced papers on these principles. Both support basing the access price on a concept of long-run marginal cost, as defined in Chapter 4.

Regulatory arrangements to prevail beyond July 1 1997

Under the Exposure Draft proposals, telecommunications will no longer be exempted from Part IV of the Trade Practices Act. Such exemption — traditionally a feature of Australian telecommunications regulation — is currently provided in the Telecommunications Act 1991, and that Act contains telecommunications-specific competition rules.

It is proposed that a new Part XIB of the Trade Practices Act will continue specific competition rules for telecommunications. This Part is aimed at allowing ACCC to act more quickly against anti-competitive conduct than it could under Part IV. In contrast to the present legislation, there will be no restrictions on 'normal competitive conduct'. This could introduce ambiguity into the operation of the Act. Competition notices issued by the ACCC which notify contravention of 'the competition rule' will be 'effects-based', not reliant on a 'purpose test'.

The intention is that eventually there will be no specific competition rules for telecommunications. The Minister will have to make arrangements to review Part XIB — with a view to its partial or total removal — before 1 July 2000.

Meanwhile, existing price capping regulation will be administered by the Australian Communications Authority, formed when parts of AUSTEL merge with the Spectrum Management Agency.

6.2 The issues considered in this study

After more than twenty years of change, the Australian telecommunications industry is still evolving, and the influence of government remains strong through regulation of the industry and ownership of Telstra. Of the many policy issues currently being debated, four are considered in detail in this study.

Natural monopoly?

What are the constraints, if any, on efficient competition in telecommunications markets? If there are natural monopoly characteristics, they have traditionally been seen to occur in the local network. Those who doubt that the local network any longer displays significant natural monopoly characteristics are relatively sanguine about the prospect of further loosening of the regulatory controls in competition in July 1997. On the other hand, those who believe that natural monopoly is still an important feature of local network technologies are concerned about the duplication that has occurred already with Optus's rollout. Chapter 2 showed that the empirical literature on natural monopoly in the local network has been relatively inconclusive. Chapter 7 examines some in-principle arguments that can bear on the issue.

Final product pricing regulation

There are various regulatory restrictions on telecommunications pricing. These include the price-capping arrangements (based on a restriction on revenue-weighted price increases to 7.5 percentage points less than the CPI and including sub-caps restricting the price increases for particular services), the Minister's notification and disallowance powers, the remains of a uniform geographical price requirement, and restrictions on timed charging of local calls. Chapter 8 sets out an analysis of the efficiency of the existing price structure and determines the extent to which the restrictions on pricing are compatible with movement to a more efficient pricing structure.

Access pricing

Competition has so far been substantially based on rivals' access to the dominant carrier's 'essential facility', the local network. The price and conditions of access have been regulated. These arrangements will continue (in modified form) after the end of the duopoly in mid-1997. The access arrangements are important to the outcome of the competitive process in terms of the efficiency of capacity provision and utilisation, and of pricing efficiency. Chapter 9 considers the alternative approaches to interconnect pricing and whether that used in Australia is compatible with efficiency. It has been suggested, for example, that Optus's decision to establish its own local network was influenced by the access pricing regime and uncertainty over its future. This could provide an additional reason (apart from possible natural monopoly considerations) why the decision to duplicate partially Telstra's local network was not compatible with economic efficiency.

Institutional structure

The dominant carrier, Telstra, has a dual role as a provider of access to, and a rival of, its competitors. This dual role, which is not the structural model of access suggested by the Hilmer (1993) report, could result in a conflict of interest. Telstra has not been divided into arms-length businesses — in particular the local network has not been separated out. Such separation would provide a basis for establishing equal access with its rivals in the long-distance, international and cellular markets. A regulatory structure — misleadingly called 'accounting separation' — has been developed as a substitute. Chapter 10 discusses these issues, and considers how well accounting separation has worked as a means of facilitating the most efficient outcome.

7 BENEFITS AND COSTS OF TWO LOCAL NETWORKS

The duplication of pay-TV/local communications networks has been a matter of concern for some observers. Given that the empirical literature on natural monopoly is relatively inconclusive (Chapter 2), this chapter reviews some recent in-principle arguments about whether the local network is or was a natural monopoly, and whether duplication should be avoided. It also reviews the evolution of policy thinking in Australia about whether the local network is or was a natural monopoly. Finally, the chapter offers a tentative conclusion on the benefits and costs of two pay-TV/local telecommunications networks.

Optus is in the process of constructing its own local network, for the purposes of providing pay-TV and in order to avoid using Telstra's local network for its own offering of telecommunications services. Optus Vision, a joint venture with Continental Cablevision, Publishing and Broadcasting and the Seven Network, is building a $3 billion fibre optic and coaxial cable network that will offer services to more that half of Australia's homes (some 3 million) by the end of 1998. Optus's rollout is primarily via overhead cable, although there has recently been a requirement for this cabling to go underground at major intersections. The network already provides pay-TV and local calls, and is geared to offer interactive services in the future. One competitive disadvantage Optus faces in the local call market, however, is that customers have to change their phone numbers if they want to subscribe to Optus.

In response to Optus's rollout, Telstra is upgrading its network to provide broadband capability. Its cable rollout will eventually pass 4 million homes and cost $4 billion. Telstra's upgrade is more expensive than Optus's, in large part because Telstra's network is predominantly underground — 'it costs $600 per home if you go ungerground; if you go aerial it costs $150 per home' (Jim Madigan, Telstra's director of customer affairs, quoted in Kimina Lyall, 'Communications Breakdown', *Australian*, 25 September 1996). However, Telstra's upgrade from cable to fibre in parts of the network will also significantly expand capacity. The network already offers pay-TV through FOXTEL Cable Television, a joint venture with News Corporation, as well as a high speed cable internet service through Telstra Multimedia using the full interactive capability of the network. Telstra is also testing a new technology that delivers local telephone calls via radio waves instead of using the local network. This will ‘give it an alternative to laying cable in some areas, and plug up gaps that might otherwise fall to Optus’ (Helen Meredith, ‘Optus gets its cable ready for telephony’, *Australian Financial Review*, 24 June 1996).

Recent concern over the unsightliness of Optus’s overhead cabling has culminated in a tightening of guidelines for Telstra and Optus. It has also led to a tighter set of planning laws to govern all competitors from July 1997, including a requirement to comply fully with local planning laws. Both Optus’s and Telstra’s rollouts can continue under their new interim guidelines until September 1997. By this stage both rollouts are expected to be largely completed.

In addition to aesthetic concerns, there have also been claims that the duplication is socially wasteful. One key issue is whether duplication has raised the real resource cost of delivering pay-TV/local communications services, or in other words, whether the local network (in conjunction with pay-TV) is a natural monopoly.

Given that the empirical literature on natural monopoly is relatively inconclusive (Chapter 2), this chapter reviews some recent in-principle arguments about whether the local network is, or was, a natural monopoly, and whether duplication should be avoided. It also reviews the evolution of policy thinking in Australia about whether the local network is or was a natural monopoly. Finally, the chapter offers a tentative conclusion on the benefits and costs of two pay-TV/local networks.

7.1 The evolution in international thinking about natural monopoly in the local network

The influence of entry

Berg and Tschirhart (1995) have recently used the fact of entry into local telecommunications markets in the United States to make inferences about relative cost structures. Taking the US regulatory environment as given, they piece together a framework relating entry behaviour to cost conditions in order to come to the following, albeit weak, conclusion: local carriers appear to be either nonsustainable natural monopolies or non-natural monopolies over the set of services they currently offer.

If the local network is a non-natural monopoly, one firm does not produce the bundle of services at a lower resource cost than two or more firms. Entry need not be prevented on the grounds that it raises real resource costs. On the contrary, entry is desirable because it can put downward pressure on the monopoly prices that a single carrier may otherwise charge.

The other possibility is that the local network is an unsustainable natural monopoly. Although the natural monopoly characteristic means that one firm can produce the bundle of services at a lower resource cost than two firms, if the situation is unsustainable there is no pricing structure that the incumbent could use to deter entry by a potential rival. Thus even without regulatory distortions that may artificially encourage inefficient entry, such inefficient entry may nevertheless occur. In this situation, the best policy response may be to regulate to prevent entry.

The empirical literature that estimates the nature of industry cost functions should in principle be able to distinguish a natural from an unnatural monopoly. As noted in Chapter 2, however, the empirical literature is inconclusive, in part because of the dependence on data sets, based on incumbent firms, that have very little variation. What can be said, however, is that it does not provide a conclusive case for a natural monopoly.

Berg and Tschirhart explain the policy problem this inconclusiveness produces, discussing the relative risks of regulation or deregulation generally. On the more narrow issue of whether there should be regulation to prevent entry and duplication, the relevant argument is as follows. If the regulatory framework wrongly assumes the presence of unsustainable natural monopoly and regulates against entry, then it risks preventing profitable entry that would lower costs, encourage rapid adoption of technological innovation and keep pace with changing patterns of consumer demand. If the regulatory framework wrongly assumes the presence of unnatural monopoly and allows entry, then it risks the consequences of deregulating a natural monopoly.

Berg and Tschirhart offer two arguments why more weight than previously should be put on avoiding the first type of error. First, the direct and indirect costs of continuing regulation are higher than in the past. Second, there is now a better understanding of the consequences of deregulating a natural monopoly, including the implications that contestibility and sustainability have for industry performance, and the realisation that even if the incumbent's technology shows natural monopoly characteristics, this does not preclude new entrants having lower costs by using alternative technologies. These points are explained in more detail below.

The influence of technology

More recently, the 'natural monopoly' characteristic of the local network has been questioned in light of advances in technology. Indeed, Rosston and Teece

(1995) go further by questioning whether the local network was ever a natural monopoly. They document the proliferation of local networks that occurred in the United States after the expiry of two key Bell patents in the mid-1890s.

> In 1894, eighty commercial systems and seven mutual systems were established. By the end of the year, new entrants had 5% of the market, or 15 000 installed phones ... By 1902, 3 000 non-Bell commercial systems had been established. The non-Bells controlled 38% of the installed phones in the USA, and 'provided direct competition to almost all Bell operating companies' (Brock [1981], p. 124; Noll and Owen, 1989). The large number of providers present and viable does not appear to be indicative of strong natural monopoly conditions. (p. 790)

Rosston and Teece note, however, that 'while the market had clearly demonstrated that it could support competition, the political winds in the early decades of this century favoured regulation' (p. 790).

According to Spulber (1995), there are three main reasons why it is no longer correct to treat the local network as a natural monopoly. First, there is no existing single best technology for telecommunications transmission. Second, the connectivity of networks eliminates the natural monopoly, because multiple carriers can provide interconnecting networks. Third, the goal of avoiding duplicative facilities is no longer an issue because substantial duplication of facilities has already occurred.

There is no single best technology for local telecommunications

The natural monopoly argument asserts that cost efficiencies are obtained from a single supplier, given the characteristics of a specific technology for carrying out a specific task. With multiple technologies, each with different characteristics, efficiency may require production by multiple firms, so that monopoly no longer yields cost efficiencies. The notion of a best technology may have once been an accurate description of the traditional telecommunications system, which consisted of copper wires for transmission, central switching equipment and basic customer premise equipment. Today, however, multiple transmission technologies exist in addition to copper wire, including coaxial cable, fibre-optic cable, satellite, microwave and cellular technologies (see Chapter 1). Each of these technologies has various advantages and disadvantages in terms of cost and performance so it is no longer possible, or desirable, to choose a single mode of transmission and exclude all others. A similar argument can be made for switching technologies. The variety of competing transmission and switching technologies implies that it is no longer possible to define a natural monopoly technology for local telephony (Spulber 1995).

It may be suggested that a combination of transmission/switching modes is best, and that this combination should be chosen efficiently by a single supplier. However, Spulber (1995) notes that this argument is plagued with difficulties, since the correct mix of technologies could be provided by multiple suppliers. Moreover, since the relative cost and performance characteristics of the alternative technologies change continuously, the optimal mix of technologies will frequently change. This is reflected in the high degree of uncertainty that currently exists about the shape of a future broadband network. Compare the following quote, in particular its predictions for services in rural areas:

> The broadband network will be a significantly reconfigured industry. Although there is no consensus on what form the reconfiguration will take, most analysts seem to agree on several key components. End users will have either coaxial cable or fiber droplines, depending on whether fiber is taken to the curb or to home. The backbone will be fiber gathered at remote terminals, and then capacity will be shared to central offices. Switching will be decentralised. In rural areas having low user density, change will be slower. Twisted copper and narrow-band service may remain the only option for some remote users. There will also be wireless personal communications networks (PCNs) that may compete with landlines or which may be viewed by end users as a complementary or substitute service. PCNs, because of their need for small cells and numerous antennas, also will be less prevalent in rural areas. (Berg and Tschirhart 1995, p. 116)

with:

> Cellular and other wireless carriers appear well situated to provide future competition for the local loop, especially in rural areas where the cost of loops is relatively high. (Rosston and Teece 1995, p. 798)

> Given the infrastructure of cable companies, CAPs [competitive access providers] and cellular carriers, and the emergence of alliances among them, a possible future competitive alternative combination would be to use CAPs to provide downtown loops, cable companies to provide loops for suburban and residential customers, and cellular companies to provide loops in rural areas. (Rosston and Teece 1995, p. 799)

In light of this uncertainty, it would be a brave government that committed itself to the technology choices of a single incumbent.

Not only is there no single best technology for traditional telephone services, there is no single best technology for handling the many new types of services the telecommunications industry now provides. The traditional telecommunications system was designed to handle voice transmission from stationary equipment. Today, however, consumers demand many alternative communications products, including fax, data transmission, interactive services, video transmission and both mobile and stationary communications. The transmission technologies vary in terms of their suitability and performance in carrying out these diverse transmission tasks.

The natural monopoly argument becomes even less applicable when it is recognised that a telecommunications company can offer an array of telephone services including basic voice transmission. The definition of natural monopoly can be extended to cover multiproduct technology. In the multiproduct case, the technology is said to have the natural monopoly property if a single firm can provide the bundle of products at a lower cost than can two or more firms. Under such conditions, the single firm enjoys economies of scope. Since distinct technologies are suitable for providing different products and services, such as voice, data transmission, interactive information services and mobile communication, the argument that a single provider is optimal is even less likely to hold.

Berg and Tschirhart (1995) explain in more detail how the introduction of new services (such as cable TV) can either create or destroy the natural monopoly characteristic of the set of services being offered. In Australia, as in the United States, new entrants are challenging the incumbent local carrier by offering both local telecommunications and other services. Support for the natural monopoly argument would require satisfying a difficult, if not impossible, burden of proving that a single provider of many diverse technologies would be cost-efficient (Spulber 1995). Thus, the question of whether the incumbent carrier is a natural monopoly over its current set of services is immaterial. The relevant policy question is whether it is a natural monopoly over an expanded set of services including pay-TV, which it may only recently have produced.

Recent technological advances in telecommunications have therefore increased the burden of proof greatly for those who wish to argue that the local network is a natural monopoly. Not only does the argument have to be extended to include additional services such as pay-TV being offered by new entrants, it also has to take into account that new entrants are offering different mixes of telephone services and using different mixes of technology. Entrants could quite conceivably have lower cost structures than the incumbent, even if that incumbent had a cost structure that did in a technical sense display natural monopoly characteristics for its own choice of technology.

The connectivity of networks weakens the natural monopoly argument

The natural monopoly argument is also weakened by the connectivity of networks. Improvements in computers and related switching technology allow different firms to build and operate multiple networks that can then be interconnected. The costs of interconnection have fallen substantially as the costs of switching technology have decreased. In addition, new developments in switching have allowed customer premises equipment such as PABXs and LANs to be substituted for transmission and switching by the telecommunications utility. Spulber (1995) argues that these significant developments render the concept of a natural monopoly telecommunications network obsolete. He quotes the former FCC chairman Alfred Sikes's testimony before Congress:

> "I do not believe that affording telephone companies expanded opportunities will result in a single network Rather, I believe there will be satellite, mobile, broadcast, as well as cable and other distribution technologies. They will provide both independent and competitive transmission paths, and will often be linked together in a network of networks." (Spulber 1995, p. 38)

In this situation, the regulatory burden can shift from comprehensive regulation of telecommunications entry and pricing to regulating the terms of interconnection. But even in this regard, the proposals by two US local carriers to offer full interconnection are significant. Rosston and Teece (1995) document how Ameritech and Rochester Telephone have recently proposed to unbundle the services they offer. Both plan to offer mutual interconnection to other carriers, as well as unbundling the local network. In Rochester Telephone's proposal this extends to unbundling the local loop from switching. Rosston and Teece note that the previous practice of bundling services can, in the presence of network externalities, create barriers to entry. The offer to unbundle services can create a market for non-deployable assets, while full interconnection ensures that all competitors can realise the same network externalities. This can lower entry barriers significantly.

> Any portion of the network that involves significant investment will be leased to competitors by the most efficient provider (initially this is likely to be the incumbent) so that if there are economies of scale or scope, all competitors and consumers will benefit. When scale and scope economies are not present, or consumers desire specific services, other providers can tailor their network services to fill those needs. (Rosston and Teece 1995, pp. 803–4)

Ameritech has agreed to freeze prices for 3 years and then subject them to price cap regulation, apparently as an assurance that it will not take advantage of any remaining market power to disadvantage its competitors while waiting for the implementation of alternative local loops.

Thus, access to local network infrastructure is being offered, not at the instigation of regulators, but on the initiative of two local carriers. This evidence offers the prospect that with sufficient competitive pressure, even the terms of interconnection eventually may not need to be regulated. However, Rosston and Teece offer a final word of caution:

> However, the future appears to be somewhat different. Voice grade telephone service may soon become simply an ancillary service provided with interactive

> two-way video service. In this case, bandwidth needs of wireless providers may currently be too great to pose an alternative to a wire-based technology. In addition, the cost to upgrade a system to provide advanced services may justify only a single wire-based system. However, the recent spate of mergers and the investment projects by both cable and telephone companies projects a world where a large number of homes will be passed by two high capacity wires and the homes will also be addressable by a large variety of wireless service providers. (Rosston and Teece 1995, p. 809–10)

The problem of duplicative facilities no longer applies

Spulber (1995) argues that the very existence of local network duplication makes the issue of avoiding duplication obsolete.

Spulber also argues that the substitution of low cost switching technology for transmission further reduces the need for concern over the duplication of transmission facilities. Substantial portions of the network can be replaced by customer premises equipment such as PABXs and local area networks (Chapter 1). The amount of duplication required by competing networks is substantially reduced, thus lowering the cost advantage of a single producer over two or more producers.

7.2 The evolution in thinking about natural monopoly in Australian telecommunications

While no empirical studies of natural monopoly in the Australian local exchange exist (because of lack of data), the issue has often been raised. In 1982, the Committee of Inquiry into Telecommunications Services in Australia (1982) concluded that:

> While there is some support for the view that economies of scale are present in trunk transmissions and in local networks, these scale economies do not appear to be of such significance as to justify an exclusion of competition and the potential benefits which competition may bring. (Volume 1, p. 48)

Moreover, the Committee reported that the cost functions of local networks have economies of scale no greater than in many other industries where competition operates successfully.

However, a 1988 Statement by the Minister for Transport and Communications (1988) reported that:

> It appears that current and emerging telecommunications technology still exhibits economies of scale and scope, as well as high sunk costs. While this evidence does not irrefutably confirm that there is a natural monopoly, it does suggest that the presence of more than one operator in the Australian market could result in overcrowding and a consequent wasteful use of resources. (p. 36)

This report cited two additional reasons why competition would be inappropriate. The first was that competition could undermine both the USOs imposed on the incumbent, and the CSOs that were (and still are) implicitly built into its prevailing price structure, threatening the viability of the incumbent at those prices. The CSOs have since been costed (BTCE 1989), but have not yet been funded explicitly from the budget. The other reason was that competition would encourage the incumbent to undertake 'tariff rebalancing' that would cut across equity objectives. Both arguments are considered in more detail in Chapter 8.

It could have been expected that the question of natural monopoly would have been revisited in the lead-up to the *Telecommunications Act 1991,* the legislation that provided for the formation and entry of Optus. The ROSA that preceded the legislation was not itself made public, but Fanning (1992) provides a commentary on the policy considerations at the time.

Fanning notes that in the deliberations leading up, and subsequent, to the May 1988 statement there was, among other things, 'a widespread perception that more competition was required in the Australian telecommunications industry if the industry's growth potential was to be realised, consumers' needs adequately satisfied and international competitiveness developed' (p. 30).

In describing that part of the ROSA report dealing with the effects of competition, Fanning mentions impacts on prices, productivity and research and development, but does not mention impacts on resource costs. In describing ROSA's section on competitive safeguards, Fanning notes

> With more competition, some infrastructure would be duplicated, but much of the competitive activity could take place using the existing carriers' networks on the basis of equitable interconnect charges or commercial agreements. It was clear that if the regulatory framework ensured that the interconnection arrangements were fair and equitable to both the incumbent and the competitor, then various arrangements to share existing facilities effectively would occur to the point where economies of scale were optimised. (p. 35)
>
> ... A competitor to Telecom would need to obtain access to Telecom's local facilities on the same terms and conditions as Telecom itself. (p. 36)

Somewhat surprisingly, Fanning's summary of ROSA does not suggest that it considered the issue of natural monopoly at all. It seems to suggest that greater policy weight was put on the problem of monopoly pricing, with equitable access arrangements being seen as sufficient to solve any problems associated with cost structures.

More recently it has been questioned whether access arrangements, particularly those arrived at by 'commercial agreement', might be truly reflective of resource costs, or whether they might instead be the outcome of collusive agreements to share monopoly rents (King and Maddock 1996a). On the other hand, it has also been questioned whether access arrangements can be arrived at which preserve the appropriate incentives for incumbents to incur the costs of investing in such facilities (IC 1995). Finally, it is also doubtful whether even a regulated access regime can yet deliver access charges that are truly cost-reflective (Appendix B). In these circumstances, it is useful to revisit the costs and benefits of duplication in an Australian context.

7.3 The cases for and against two pay-TV/local communications networks

As noted, Optus is in the process of constructing its own local network while, at the same time, Telstra is upgrading its network to provide broadband capability. Quiggin (1996, pp. 132–4) claims that the 'social cost of this duplication is enormous' because:

- 'consumers of phone and pay-TV services will pay at least twice as much for the network as they would have paid for a single network', partly because of duplication per se and partly because the speed of the rollout/upgrade will, he claims, increase costs for both parties;
- the service from hybrid fibre-coaxial cable systems arguably is technically obsolete; and
- Optus's overhead cable system is inferior to Telstra's underground system.

Some of these claims are likely to be exaggerated, perhaps substantially. The hybrid cable system laid by Telstra can be converted from analogue to digital by changing the equipment which encodes and decodes the signals — thus, the trenches (or poles), the conduit and in many cases the cable itself is not obsolete. In addition, it is unlikely that Optus will duplicate all of Telstra's local network — at this stage its rollout plans are confined to the major cities. Similarly, it is unlikely that Telstra's upgrade will duplicate the network constructed by Optus, either geographically or technologically. Thus, the real resource cost of the two networks is unlikely to be anywhere near 'more than double' that of one local network.

Even if duplication pushes up the real resource cost of providing telephone services, the price to consumers need not rise. There is some evidence (Chapter 9) that, even in the current duopoly situation, the increased competition provided by Optus's rollout has put downward pressure on the 'wholesale' price of access to Telstra's network. There is also clear evidence that Optus's rollout has encouraged Telstra to upgrade the quality of its network earlier than it otherwise would. If these benefits are passed on to consumers in the form of lower retail prices or better service, consumers will clearly gain. Part of this benefit may be at the expense of carrier profits from existing levels of service, but part would be consumer surplus which, together with profits on additional service, would represent a net gain to society.

Though duplication could represent an improvement on the previous status quo, a relevant policy question is whether an alternative policy action could have generated an even better outcome. This seems a particularly pertinent question when ‘the technology allows a single broadband network to carry more than all the needs of the nation’ (Bruce Donald, ‘‘Unbundling’ could relieve duplication’, *Australian Financial Review*, 1 February 1996).

Suppose the local network (in conjunction with pay-TV) is a natural monopoly. In such a situation, one carrier can provide the local telecommunications and pay-TV services more cheaply than two. So long as prices to consumers can be regulated through some means (other than competitive forces) to prevent monopoly pricing, it therefore would be better to have only one carrier.

But which carrier? This in turn depends on why Optus entered. If it entered because its resource cost of providing network services was lower than Telstra’s, then its entry is desirable (and could presumably foreshadow the commercial demise of Telstra). Unfortunately, it is not clear that Optus entered because of lower real resource costs. One of the alternatives available to Optus was to provide its services through Telstra’s network. However, if the terms of Optus’s access to Telstra’s network exceeded the real resource cost of its network use, Optus could have had an incentive to avoid those access charges by undertaking its own rollout, even if that rollout was more expensive in resource terms than using Telstra’s network. While it is unlikely that this was the prime reason for Optus’s rollout, there is some evidence that the charge for Optus’s access to Telstra’s network was initially set above the real resource cost of using the network (Chapter 9). Even so, if Telstra’s resource costs are lower than Optus’s, it could still use that advantage to ensure the commercial demise of Optus. A more worrying prospect, however, is that with the legislative protection from further competition, the two carriers have settled into an arrangement that allows them both profitably to explore their market power, irrespective of relative resource costs (see also Chapter 10).

One further possibility, at least in theory, is that pay-TV/local telecommunications services are an unsustainable natural monopoly. Thus, even without a regulatory access charge that may artificially encourage inefficient entry, such inefficient entry may nevertheless occur. In this situation, the best policy response may have been to regulate to prevent entry.

Given that entry has already occurred, it is less clear whether it would be appropriate to regulate to prevent further expansion of the duplicate network in a situation of unsustainable natural monopoly. This is because Optus has already incurred some sunk costs — costs that cannot be recouped should it be forced out of business or prevented from expanding. If there was social 'damage' from its entry (in the form of inefficiently incurring sunk costs), some of that damage will have been done already. Were the current duopoly to persist in the future, there could be a case for intervening to prevent further damage since, in a duopoly situation, virtually all of Optus's rollout costs are likely to be sunk. Post-1997, new entrants could become prospective purchasers (or leasers) of Optus's network, possibly even 'unsinking' some of Optus's currently sunk costs.

7.4 Conclusion

To a large extent, judgments about whether network duplication is socially wasteful hinge on the perceived balance between the prospect that duplication raises resource costs, relative to the prospect that competition reduces monopoly prices and generates benefits for consumers. A case for regulating to prevent entry could be made only when this balance is negative, and when there there are significant 'sunk' costs that cannot be recouped in the event that an entrant leaves the industry. Recent trends towards unbundling and interconnection have reduced the extent to which costs are sunk. In terms of competition, July 1997 will see the end of the duopoly in Australian telecommunications. Depending on the terms of interconnection, this offers the prospect of renewed price competition to the benefit of consumers. A third unknown is the likely configuration of future least-cost technologies. This very uncertainty may make it unwise to depend on the technology choices of a single incumbent.

8 REGULATION AND THE EFFICIENCY OF FINAL PRODUCT PRICING

This chapter contains a description of the Australian telecommunications pricing structure and an assessment of the directions in which prices would have to move to make it more efficient. It begins with a review of the regulatory factors that have shaped the existing price structure. This is followed by an overall assessment of the efficiency of the existing price structure viewed in the light of the principles discussed in Chapter 4. Next, there is a report of a quantitative study of the potential gains from moving to alternative, more efficient pricing structures better reflecting costs of production and demands. The details of this study are set out in Appendix C. Finally there is an assessment of the distributional implications of greater efficiency of telecommunications pricing and a sketch of possible compensation schemes.

8.1 Regulatory influences on Australian telecommunications pricing

Successive Australian governments have used a variety of legislative means to influence telecommunications prices. The objectives of these regulations have not always been clearly-defined, but have tended to revolve around either social goals or the desire to control monopoly power. Social goals have included increasing the penetration of the telephone, both geographically and among lower-income groups.

Uniform geographical pricing and community service obligations

The government-owned principal telecommunications service provider has traditionally had a statutory obligation to provide 'basic services' at a uniform price, and obligations to provide concessional prices to some users. These two forms of obligation have been known in recent years as USOs and CSOs, respectively. These obligations mean that some prices are artificially low, while others — those that incur a 'tax' to meet the cost of the 'subsidies' — are too high.

The arrangement by which these transfers occur is usually called a 'cross-subsidy'. In Australian discussions, the definition of 'cross-subsidy' has not always been clear (see Lindsay and Williams 1995, pp.109–111), often overlooking Faulhaber's (1975) definitions (see Chapter 4). The accepted definition of 'subsidy' is an arrangement which involves pricing below avoidable incremental cost. Following a detailed study by the Bureau of Transport and Communications Economics (1989), it is now accepted that the appropriate way to cost the USO is through the avoidable incremental cost methodology.

Under the existing arrangements, Telstra is required to estimate the cost of the USO each year and present its estimate to AUSTEL. The estimate may be the subject of negotiation between AUSTEL and Telstra. In 1994–95, the USO was costed by AUSTEL at $235.8 million (AUSTEL, 1996 p. 33). The cost of the USO is shared by the three carriers — Telstra, Optus and Vodafone — on the basis of their provision of paid minutes of telecommunications services. Accordingly Telstra pays a large (94 per cent in 1994–95) but diminishing share of the USO cost.

Price capping regulations

Since 1989, AUSTEL has administered a form of price capping regulation based on that devised for British telecommunications (Littlechild 1983) and loosely consistent with a theoretical foundation established by Vogelsang and Finsinger (1979). The 'CPI – X' price capping allows Telstra some flexibility in price setting as long as the revenue weighted average of prices of services in the capped basket rises by less than the percentage increase in the consumer price index less some specified percentage, 'X'. However, there is the further constraint on Telstra's pricing through the specification of sub-caps on particular prices, preventing them from rising by more than specified amounts.

The 'X' in the price capping formula can be interpreted as an allowance for the cost reductions from technological change and/or a factor reflecting an objective to remove above-normal profits. In Australian application, the first interpretation has tended to be emphasised. Initially, X was set at 4 per cent, with this rate to apply during the first triennium (mid-1989 to mid-1992). After the first review, the constraint was tightened for the second triennium (mid-1992 to mid-1995 and extended to the end of 1995) by raising X to 5.5 per cent. For the current triennium — now based on calendar years — from 1996 to 1998, the X factor has been set at 7.5 per cent. At each stage the research effort devoted to determining X has been based largely on the past course of Telstra's total factor productivity (TFP) growth.

The sub-caps on particular prices mean that Telstra is not completely free to vary its prices within the CPI – X constraint. The sub-caps impose a freeze on the standard local call charge, and a CPI – 1 constraint on all basic residential services (connections, access rentals, long-distance and international calls).

The sub-caps are unlikely to bite for residential STD and IDD prices. Market and cost pressures on these prices are decidedly downwards. However, Telstra's ability to lower these prices is partially determined by the extent to which residential access prices and local call prices can be varied upwards, and this is constrained by the sub-caps. The extent to which the sub-caps restrict the efficiency gains from price rebalancing are assessed as part of the quantitative analysis of pricing efficiency later in this chapter.

Notification and disallowance

The traditional approach to regulation — through controls on particular prices — continues for those items subject to Notification and Disallowance (N&D) provisions. These give the Minister direct price control powers over particular designated services not subject to price capping. Currently this direct control applies to directory assistance, public payphone charges and interconnection charges for non-carriers. Telstra must submit proposed charges to the Minister, who may refer them to AUSTEL for report within 30 days. The Minister is not bound by recommendations from AUSTEL.

8.2 The broad structure of Australian telecommunications pricing

The Australian telecommunications pricing structure is a product of a variety of factors relating to costs and technology, user demands, competition and political decisions about the use of telecommunications pricing for non-economic purposes. The result is what many see as a rather inefficient structure in need of substantial 'rebalancing'. Broadly there are three main problems with the existing structure.[1]

First, there is a broad imbalance between use and non-use charges, with use charges being broadly too high, making an excessive contribution to unallocable overheads and profits relative to non-use-related charges (Minister for Transport and Communications 1988, p. 24, Ergas, Ralph and Sivakumar 1990, B.2.50–54). Use charges for all major items are well above long-run marginal cost, and even further above short-run marginal cost. Access charges

[1] The analysis in the following sections builds on earlier work by Albon (1988).

do not even cover the costs of providing customer access. While customer access provision has to be supported from other revenues, efficiency considerations suggest they should be making a net contribution.

Second, the structure of use prices is inefficient, with any deviations of prices from (long-run marginal) costs of provision not reflecting elasticities of demand, as required under the Ramsey-Boiteux principle (see Chapter 4). While prices have been moving (very slowly) in the right directions, there are still substantial variations in marginal deadweight losses, with long-distance and international prices in particular imposing excessive marginal deadweight losses.

Third, peak-load pricing principles are not employed in pricing of the local network (Ergas 1986, pp. 106–107), although the importance of this has decreased as technological change has progressively reduced the cost of meeting peak demands (see also Chapter 1).

Consider now how these broad deficiencies translate into issues surrounding the prices of particular services.

Customer access network

Customer access charges are too low. They fail to cover costs of providing access, much less make a contribution to unallocable overheads (Ergas, Ralph and Sivakumar1990, B.2.50–54).

Assuming that any CAN subsidies for social and externality reasons continue to be met by direct government subsidies, the CAN should at least generate revenues equal to its full costs. The revenue and cost estimates in Appendix B suggest an overall CAN deficit of $597 million. The average annual cost of subscriber access is about $235 ($2 162 million/9.2 million subscribers) in 1995–96. Cost recovery, which would involve moving prices to long-run marginal cost, for residential and business access categories suggest that residential access charges would have to rise from $140 to $235 a year (or to about $20 per month) and business access charges to fall from $240 to $235 a year (see Appendix B).

On the basis of either the two-part pricing or Ramsey-Boiteux approaches, the CAN would also be expected to meet at least some unallocable overheads, with allocations based broadly on willingness to pay. Business subscribers have a very inelastic demand (see Chapter 3). This suggests that a ‘premium’ could be charged on business rental.

Customer access charges are also poorly structured, with a horizontal structure not reflecting the costs of providing access to different customers (Treasury 1983, p. 280).

Local calls

Local calls are charged at a flat rate of 25 cents, unless subject to a flexi-plan, under which the price can be as low as 21 cents. The average price is estimated at 23.2 cents, well in excess of the average cost of less than 10 cents per call (Appendix B). The price rebalancing analysis presented in the next section reveals that, given the highly inelastic demand for local calls and given the existing total contribution from basic carriage services and the levels of other prices, this margin is roughly consistent with the Ramsey-Boiteux principle.

The existence of different charging bases for use of the local network by Telstra, Optus and service providers (see Chapter 10) is inefficient. There is a case for time-based charging for all uses, with the charge varying from peak through to off-peak use. Efficient pricing of the local network would charge equipment dedicated to meeting peak traffic demands against peak traffic. This does not currently occur for local calls, which comprise the main use of the local network. However, the extent of the difference between peak and off-peak prices necessary for efficiency may be decreasing as new technologies allow the handling of peak demands.

Long-distance calls

Long-distance minute prices differ according to distance of the call and when the call is made. Calls are timed for charging purposes. However, there appear to be inefficiencies from both the overall level and the pricing structure of long-distance calls.

Perhaps most importantly, there is an excessive average gap between the price and long-run marginal cost, and the amount of revenue raised from long-distance calls overall is too high given the lower marginal deadweight losses from raising net revenues by other means. This flows from there being a very large mark-up combined with a relatively elastic demand, so that the Ramsey-Boiteux rule is not observed.

While this factor is not taken into account in the empirical analysis below, there appears also to be an excessive allowance for the costs of distance in pricing. The compression in the rate structure for longer distances has not been as rapid as the reduction in relative costs of longer-distance calls.

International calls

International call prices are too high on average, even when considered against their 'accounting' costs of provision (which are artificially inflated as a consequence of the international settlement arrangements). International calls have a very elastic demand. The high mark-ups on accounting costs therefore result in a marginal deadweight loss in excess of that on other sources of net revenue.

International prices are more excessive when viewed against the benchmark of resource costs. International settlement costs are well in excess of the resource costs of international carriage. The excess of settlement rates over resource costs and broader issues surrounding the structure of international prices have not been considered in this study.

8.3 Efficiency gains from price rebalancing

Rebalancing Telstra prices

The price rebalancing analysis reported on here examines five of Telstra's telecommunications services: residential customer access, business customer access, local calls, long-distance calls and international calls. The starting point for the price rebalancing analysis is the estimated 1995–96 Telstra pricing structure described in the previous section and summarised below in Table 8.1. The source and generation of this cost, price and traffic data is discussed in Appendix B.

In order to calculate the change in traffic from the estimated 1995–96 pricing structure (and hence the change in revenue, cost and efficiency) resulting from a rebalancing of prices, the price elasticity of demand is also required for each of the five telecommunications services examined. The elasticity estimates used in the price rebalancing analysis (also presented in Table 8.1) are drawn from Chapter 3 and Appendix A, which reviewed a range of empirical telecommunications demand studies. The estimates used are conservative.[2] The sensitivity of the price rebalancing results to variations in these elasticity

[2] The analysis assumes that the slope of the inverse demand curve, rather than its price elasticity, remains constant as prices change. This leads to a conservative estimate of the efficiency gains from reductions in call prices. In addition, the analysis ignores the cross-price elasticity of demand for access, whereby reductions in call prices could increase the demand for access and lead to further increases in efficiency.

estimates is examined in Appendix C. The distributional implications of price rebalancing are considered in Section 8.4.

Table 8.1: **Estimates used in the price rebalancing analysis, 1995–96**

Telstra markets	*Price*	*Long-run marginal cost*	*Traffic/ quantity*	*Price elasticity of demand*
Residential customer access	$139.8 per connection	$235 per connection	6.45 million connections	-0.04
Business customer access	$240 per connection	$235 per connection	2.76 million connections	0.00
Local calls	$0.232 per call	$0.099 per call	11.2 billion calls	-0.06
Long-distance calls	$0.311 per minute	$0.124 per minute	9.51 billion minutes	-0.60
International calls	$1.129 per minute	$0.759 per minute	638 million minutes	-1.20

Source: Appendix A, Appendix B and Chapter 3.

The data presented in Table 8.1 reveal that there is a gap between price and long-run marginal cost in each of the five telecommunications markets. As discussed in Chapter 4, economic efficiency will be maximised when price equals marginal cost. Therefore, the gap between Telstra's marginal cost of a telecommunications service and the price it charges consumers imposes a loss in economic efficiency.

While marginal cost pricing will eliminate this loss in economic efficiency, it will not meet Telstra's net revenue constraint. In 1995–96, total revenue less total cost for the five Telstra markets was approximately $2.9 billion. This net revenue goes towards meeting Telstra's non-allocable costs and towards profits. The pricing solution that continues to meet this net revenue constraint will obviously involve price being above marginal cost for at least one of the five telecommunications services. The objective of the price rebalancing analysis is to find the pricing solution for the five telecommunications services that would minimise the loss in economic efficiency, or maximise the gain in efficiency over the 1995–96 structure, while continuing to meet the $2.9 billion net revenue constraint.

Table 8.2 summarises the results of the Telstra price rebalancing scenarios and Appendix C provides details of the estimation of these efficiency gains from price rebalancing. The additional efficiency effects from Optus following Telstra's price rebalancing are examined in the next section.

The first price rebalancing scenario allows the prices of all five telecommunications services to vary in order to maximise the efficiency gains over the 1995–96 pricing structure, while still meeting the $2.9 billion revenue constraint. Obviously, this scenario is an extreme case and is included here to illustrate the impacts of rebalancing Telstra prices when no additional price constraints are applied. As expected, the business customer access market, which has an estimated zero price elasticity of demand, contributes the entire net revenue constraint of $2.9 billion. The price of business customer access increases from $240 to $1 287 a year. Prices in the other four markets are all driven to long-run marginal cost. The total efficiency gain from moving from Telstra's estimated 1995–96 pricing structure to this pricing solution is estimated to be $402 million.

Obviously, such a large increase in the price of business customer access is unlikely to be implemented in practice. The reason is that it is not known whether the price elasticity of demand for business customer access would remain at zero in the face of such a large price increase. Therefore, a second scenario is examined under which the price of business customer access is constrained to a more realistic value ($350), while allowing the prices of the four remaining services to vary. This results in the price of residential customer access increasing well above marginal cost, to $354 per year, and the price of a local call increasing slightly from 23.2 cents to 23.5 cents. The price per minute for long-distance and international calls falls towards marginal cost. The total efficiency gain over the 1995–96 pricing structure is estimated to be $356 million.

However, a pricing solution that increases the price of residential customer access from below the business access price to above it would be difficult to implement in practice. Therefore, a third scenario introduces an additional constraint — the price of residential customer access must equal its long-run marginal cost ($235). This scenario results in the price of a local call increasing to 29.1 cents and the per minute price of long-distance and international calls falling, but by less than under the previous scenario. The total efficiency gain from this pricing solution over the 1995–96 Telstra pricing structure is estimated to be $337 million.

Table 8.2: **Results of price rebalancing scenarios for Telstra**

Scenario		*Telstra telecommunications market*					
		Residential customer access	*Business customer access*	*Local calls*	*Long-distance calls*	*International calls*	*Total*
1995–96 price		$139.8	$240	$0.232	$0.311	$1.129	
Scenario 1[a]	Solution price	$235	$1287	$0.099	$0.124	$0.759	
	Efficiency gain[f] $m	$8	$0	$26	$322	$46	$402
Scenario 2[b]	Solution price	$354	$350	$0.235	$0.148	$0.804	
	Efficiency gain[f] $m	-$5	$0	-$1	$317	$46	$356
Scenario 3[c]	Solution price	$235	$350	$0.291	$0.158	$0.822	
	Efficiency gain[f] $m	$8	$0	-$28	$312	$45	$337
Scenario 4[d]	Solution price	$235	$350	$0.232	$0.209	$0.919	
	Efficiency gain[f] $m	$8	$0	$0	$255	$38	$301
Scenario 5[e]	Solution price	$140	$350	$0.232	$0.272	$1.036	
	Efficiency gain[f] $m	$0	$0	$0	$119	$21	$140

[a] Net revenue neutral with no price constraints.
[b] Net revenue neutral with business customer access price equal to $350.
[c] Net revenue neutral with business customer access price equal to $350 and residential customer access price equal to $235.
[d] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $235 and local call price less than or equal to $0.232 per call.
[e] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $140, local call price less than or equal to $0.232 per call, long-distance price less than or equal to $0.311 per minute and international price less than or equal to $1.129 per minute.
[f] Efficiency gain over the estimated 1995–96 pricing structure.

However, as discussed in Section 8.1, the AUSTEL price sub-cap regulation on local calls freezes the standard local call charge to equal or below its current level. Also, any pricing solution that increases the price of a local call is likely to be unattractive to Telstra because of competition in the local call market.

Therefore, an additional constraint is introduced to examine the effect of the sub-cap regulation on local calls. The price of a local call is constrained at or below its 1995–96 estimated average price of 23.2 cents per call. This scenario (scenario 4) results in the per minute price of long-distance and international calls falling by less than under the previous scenario, to 20.9 cents and 91.9 cents, respectively. The total efficiency gain over the 1995–96 pricing structure is estimated to be $301 million. The difference in the efficiency gain between scenario 3 and scenario 4 ($36 million) represents the efficiency cost of the sub-cap regulation on local calls when business customer access is set at $350 per year and the price of residential access is constrained to its long-run marginal cost.

In addition to the local call sub-cap regulation, the AUSTEL price sub-cap regulations also constrain the price of residential access rental, long-distance and international calls. Therefore, a fifth scenario constrains the price of residential access, long-distance and international calls to be equal or below their 1995–96 levels. This results in the residential customer access price being set to its 1995–96 level of $140 per year and the price per minute of long-distance calls and international calls falling to 27.2 cents and $1.04, respectively. The efficiency gain resulting from this scenario over the 1995–96 pricing structure is estimated to be $140 million. The efficiency gain difference between this scenario and scenario 4 ($161 million) represents the efficiency cost of the residential access price sub-cap when the price of business customer access is set at $350, the price of residential customer access is constrained to long-run marginal cost and the price of a local call is constrained to be at or below its 1995–96 level.

Incorporating effects of changes in Optus's prices

The efficiency gains reported above are the result of Telstra rebalancing its pricing structure. Ideally, they should be calculated using demand elasticities faced by Telstra. However, the elasticities used in the analysis were estimated for the whole industry. They would nevertheless be the appropriate ones to calculate efficiency gains from Telstra's rebalancing if Optus were to follow Telstra's price adjustments, since in this case both participants would face the same demand elasticity as for the whole industry. In reality, Optus would be likely to follow Telstra's price adjustments, at least to some extent.

With Optus following Telstra's price adjustments, this would generate its own efficiency gains on top of those generated by Telstra's rebalancing. In 1995–96, Optus operated in only two of the markets included in the price rebalancing analysis — those for long-distance and international calls. The solution prices found for Telstra long-distance and international calls can be used to adjust Optus prices and to calculate the resulting efficiency changes over the estimated 1995–96 Optus pricing structure (see Appendix C).

First, Optus long-distance and international call prices are adjusted to equal the solution prices found for Telstra under each of the scenarios. The resulting efficiency gains from both Telstra's and Optus's rebalancing are presented in Table 8.3. Rebalancing Telstra prices and then equating Optus prices with the Telstra solution prices for long-distance and international calls results in an increase in total efficiency, relative to the 1995–96 Optus and Telstra pricing structures, under all scenarios. As expected, the efficiency gains are smaller when more price constraints are introduced under each scenario.

Table 8.3: **Efficiency gains from rebalancing Telstra prices and equating Optus prices to Telstra solution prices**

Telstra rebalancing scenario	*Efficiency gains relative to Telstra's and Optus's 1995–96 pricing structures* *$ million*			
	Optus long-distance	Optus international	Optus total	Optus and Telstra total
Scenario 1[a]	50	12	62	464
Scenario 2[b]	49	12	61	417
Scenario 3[c]	48	12	60	397
Scenario 4[d]	37	9	46	347
Scenario 5[e]	11	3	14	154

[a] Net revenue neutral with no price constraints.
[b] Net revenue neutral with business customer access price equal to $350.
[c] Net revenue neutral with business customer access price equal to $350 and residential customer access price equal to $235.
[d] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $235 and local call price less than or equal to $0.232 per call.
[e] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $140, local call price less than or equal to $0.232 per call, long-distance price less than or equal to $0.311 per minute and international price less than or equal to $1.129 per minute.

An alternative range of efficiency gains is also estimated by assuming that Optus's margin below Telstra prices remains intact after rebalancing. In 1995–96, Optus's average estimated per minute prices for long-distance and international calls were lower than the estimated Telstra per minute prices by about 5 per cent. Table 8.4 presents the estimated efficiency gains when Telstra prices are rebalanced and Optus' prices are adjusted to maintain their margin below Telstra's prices. Again, efficiency gains over the 1995–96 Telstra and

Optus pricing structures are found under all scenarios. Efficiency gains are smaller when more constraints are introduced. However, efficiency gains are generally larger than when Optus's prices are equated with Telstra's solution prices.

Table 8.4: **Efficiency gains from rebalancing Telstra prices and maintaining Optus's price margins below Telstra prices**

Telstra rebalancing scenario	*Efficiency gains relative to Telstra's and Optus's 1995–96 pricing structures* *$ million*			
	Optus long-distance	Optus international	Optus total	Optus and Telstra total
Scenario 1[a]	50	12	62	464
Scenario 2[b]	49	13	62	418
Scenario 3[c]	49	12	61	398
Scenario 4[d]	40	11	51	352
Scenario 5[e]	19	6	25	165

[a] Net revenue neutral with no price constraints.
[b] Net revenue neutral with business customer access price equal to $350.
[c] Net revenue neutral with business customer access price equal to $350 and residential customer access price equal to $235.
[d] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $235 and local call price less than or equal to $0.232 per call.
[e] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $140, local call price less than or equal to $0.232 per call, long-distance price less than or equal to $0.311 per minute and international price less than or equal to $1.129 per minute.

The effects of planned cost reductions

The scenarios examined above all constrained Telstra's net revenue from the five markets to its current estimated level of $2.9 billion. However, this level of net revenue seems unusually high. Telstra chief executive, Mr Frank Blount, has stated that Telstra is not yet at world's best practice in terms of operating expenses per access line — 'We make no secret that we are 35 per cent from where we ought to be' ('Blount and to the point on sale', *Australian Financial Review*, 28 June 1996).[3] This means that the pricing structures found under

[3] Operating expenses per access line is but one of a number of performance indicators — see BIE (1995b). While it may not always provide a good basis for making comparisons among operators, the point of the quote is that Telstra can reduce its own costs over time.

scenarios 1 to 5 are possibly being held artificially high, and hence the estimated efficiency gains over the current pricing structure are too low. To examine the extent of the changes in the solution prices and efficiency gains from planned cost reductions, all costs (long-run marginal costs and other Telstra costs) in the price rebalancing analysis were reduced by 26 per cent (0.35 ÷ 1.35).

The lower net revenue constraint was calculated by arbitrarily assuming that Telstra's 1995–96 estimated net revenue of $2.9 billion from the five telecommunications services was divided equally between profit and covering other costs, such as net losses in other Telstra services (eg directory assistance) and Telstra headoffice overheads. In practice, this is clearly unlikely to be the case. Consequently, the following estimates should be regarded as only illustrative of the possible gains from cost reductions.

Under the new revenue constraint, the 1995–96 contribution to profit was maintained, while the cost contribution was reduced by 26 per cent. Thus, the new net revenue constraint was calculated as $2.5 billion by holding the net revenue contribution to profit at $1.46 billion ($2.9 billion x 0.5) and reducing the net revenue contribution to costs to $1.07 billion ($2.9 billion x 0.5 x 0.74). In addition, the long-run marginal costs of the five telecommunications services were also reduced by 26 per cent.

The estimated efficiency gains resulting from Telstra rebalancing its prices and reducing its costs by 26 per cent are substantially higher than in the original analysis, and the difference between the efficiency gains increases as more constraints are introduced under each scenario (Table 8.5). In this case, prices generally have to fall to move back into alignment with long-run marginal costs, though individual prices also have to move either up or down to meet the requirements of rebalancing.

It is also important to note that the price rebalancing analysis summarised here is limited to five telecommunications services. However, in practice there is a range of other telecommunications services provided by Telstra, such as mobile services, directory assistance and customer premises equipment maintenance, that could potentially increase the estimated efficiency gains if included in the price rebalancing analysis. For example, the cost of providing directory assistance has been reported at $250 million per year and is projected to cost Telstra $400 million by 2000 ('Telstra renews push for directory help fee', *Weekend Australian*, 29/30 June 1996). However, the service is provided free to consumers. Setting the price of directory assistance service closer to its long-run marginal cost would increase efficiency in itself, as well as indirectly by reducing the need for subsidisation from other Telstra services, thus allowing their prices to fall.

Table 8.5: **Price rebalancing results assuming reduced Telstra costs**

Telstra rebalancing scenario	*Efficiency gains relative to Telstra's 1995–96 pricing structure* *$ million*					
	Residential customer access	*Business customer access*	*Local calls*	*Long-distance calls*	*International calls*	*Total*
Scenario 1[a]	1	0	37	442	109	589
Scenario 2[b]	-7	0	21	439	109	562
Scenario 3[c]	1	0	6	435	108	550
Scenario 4[d]	1	0	6	435	108	550
Scenario 5[e]	0	0	0	432	108	540

[a] Net revenue neutral with no price constraints.
[b] Net revenue neutral with business customer access price equal to $350.
[c] Net revenue neutral with business customer access price equal to $350 and residential customer access price equal to $174.
[d] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $174 and local call price less than or equal to $0.232 per call.
[e] Net revenue neutral with business customer access price equal to $350, residential customer access price equal to $140, local call price less than or equal to $0.232 per call, long-distance price less than or equal to $0.311 per minute and international price less than or equal to $1.129 per minute.

8.4 Distributional implications of price rebalancing on households

The objective of the price rebalancing analysis presented above is to find the set of prices for a range of telecommunications services which would maximise the total efficiency gains relative to the 1995–96 pricing structure. While many households would benefit from the introduction of the price structures found under the rebalancing scenarios, others may lose. For example, under the price rebalancing scenario 4, the price of residential access increases from $140 to $235 per year, the prices of long-distance and international calls decrease and local calls are kept at their 1995–96 level. For households whose expenditure on access and local calls makes up a large proportion of total expenditure on telecommunications services, this pricing structure may make them worse off than the 1995–96 pricing structure. An increase of $95 in the access charge may even result in some households discontinuing access.

This section examines the distributional impacts of price rebalancing under scenario 4 solution prices found in the previous section. Scenario 4 was chosen because it is the most conservative solution in terms of potential price changes while still resulting in substantial efficiency gains. The solution prices under scenario 4 ignore the AUSTEL sub-cap regulation on residential customer access.

To find which household groups may potentially be made worse off under the scenario 4 solution pricing structure, household telephone expenditure data were examined. The 1993–94 Household Expenditure Survey (HES) provides household net expenditure on telephone and telegram charges, which includes expenditure on telephone accounts, expenditure on telephone calls from public payphones and expenditure on phone cards. To help identify which households would be most likely to discontinue access if the access charge increased, the HES was used to calculate telephone penetration rates by income decile (see Table 8.6).

The penetration rate for all households in 1993–94 was 92 per cent. This penetration ratio is inconsistent with the report in AUSTEL (1996, p. 8) that the penetration rate in residential households was 94.4 per cent at 30 June 1991 and 96.4 per cent at 30 June 1996, implying around 95 per cent in 1993–94. AUSTEL's figures are based on surveys. Telstra reports a penetration rate of '96 per cent of households' (*Annual Report 1996*, p. 9).

The penetration rates in Table 8.6 varied considerably among income deciles. In the two lowest income deciles the penetration rate was only 88 per cent, indicating that households in these two deciles are likely to be the most vulnerable to increases in the telephone access charge.

Average telephone expenditure by income decile for those households that have telephone access (see Table 8.6) indicates that, generally, lower income deciles spend less than higher income deciles on telecommunications services. However, the HES does not provide information on the composition of telephone expenditure (ie access, connections, public calls, local calls, long-distance calls, international calls and mobile calls) which makes it impossible to determine how each income decile would be affected by introducing the rebalanced pricing structure found under scenario 4. The composition of telephone expenditure is collected by Telstra, but the data are not publicly available.

Table 8.6: **Estimated telephone penetration rates and average telephone expenditure by income decile**

Income decile	*Telephone penetration rate*	*Average telephone expenditure* [a]
	%	$ per year
1	88.35	575
2	87.61	494
3	92.89	582
4	91.84	705
5	92.30	673
6	93.04	734
7	93.96	770
8	94.25	728
9	94.70	788
10	94.26	943
Total	92.32	702

[a] Average telephone expenditure for those households that have telephone access, assumed to be those households with net expenditure on telephone and telegram charges in excess of $80 per year.

Source: NATSEM (1996).

Therefore, a possible compensation scheme was considered for those households that would be most likely to be made worse off by introducing the scenario 4 rebalanced pricing structure. To overcome the problems involved in identifying low income households, it was decided to target the compensation scheme to a more easily identified household group. The compensation scheme was calculated for households which had as their principal source of income a government transfer or superannuation *and* whose income was in one of the lowest three income deciles. According to the HES, this target group made up 23 per cent of households that had residential telephone access in 1993–94, and had an average annual telephone expenditure of $549. Therefore, the compensation scheme was calculated for 23 per cent of connected households in 1995–96.

To ensure that targeted households would be made no worse off under the rebalanced prices than they were under the 1995–96 pricing structure, the compensation scheme would have to subsidise fully the increase in the residential access charge of $95. Therefore, after price rebalancing and with the compensation scheme, targeted groups would face the same price for access and local calls as they did under the 1995–96 pricing structure and lower prices for long-distance and international calls, thus making them no worse off if they made only local calls and better off if they made any long-distance or international calls.

This compensation scheme is estimated to cost approximately $142 million (6 450 500 residential connections x $95 x 23%) in 1995–96. There is a range of options for funding the scheme, including a decrease in Telstra operating costs (and no increase in net revenue), an increase in the price of other telecommunications services and funding directly from consolidated revenue.

A decrease in operating costs would be the least costly in terms of efficiency. In 1995–96 Telstra's total costs (revenue minus operating profit) were reported to be $11 792 million. A decrease in total Telstra costs of just 1.2 per cent would fund the entire compensation scheme. During 1995–96 Telstra achieved its 'targeted 10 per cent average reduction [in unit costs] across a broad range of products' (*Annual Report 1996*, p. 10). Funding the scheme is a small part of one year's efficiency gain. In more concrete terms, elimination of the reported $200 million loss on installation and maintenance of CPEs would more than cover the cost of the scheme (Steve Lewis, 'Telstra plan to stem $200 m CPE bleeding', *Australian Financial Review*, 19 November 1996).

Funding the compensation scheme from an increase in the price of other telecommunications services would in most cases reduce the efficiency gains from rebalancing the 1995–96 pricing structure.[4] Funding the compensation scheme entirely from an increase in the price of business customer access would require the rebalanced price of business customer access to increase by $51 to $401 per year. There would be no decrease in efficiency from this price increase because the price elasticity of demand for business access is estimated to be zero. If instead, the compensation scheme was financed entirely from the local calls market, the price of a local call would have to increase from 23.2 cents to 24.5 cents. The reduction in efficiency gains from the scenario 4 rebalanced pricing structure would be $5 million.

Funding the scheme from the long-distance call market alone would increase the price of a long-distance call minute from its rebalanced price of 20.9 cents to 22.4 cents and reduce the efficiency gains from the price rebalancing scenario 4 by $27 million. The compensation scheme could not be funded from the international calls market alone without increasing the price of an international call minute above its 1995–96 price. However, the compensation scheme could be funded by a combination of price increases in the long-distance and international calls markets. This would result in the rebalanced

[4] Funding the scheme from a directory assistance charge would involve an efficiency gain rather than a loss (so long as the charge did not greatly exceed the marginal cost of providing the directory assistance).

price of long-distance call minutes increasing to 22.3 cents and the price of international call minutes increasing from its rebalanced price of 91.9 cents to 94.3 cents. This funding arrangement would reduce the efficiency gains of price rebalancing by $25 million.

Finally, the compensation scheme could be funded directly from consolidated revenue. While this would allow the realisation of the full efficiency gains from telecommunications price rebalancing, there would be an efficiency loss from the excess burden of the taxation necessary to fund the subsidy. At a marginal deadweight loss of 20 cents, funding the compensation scheme results in an efficiency loss of $28 million (Findlay and Jones 1982).

It is important to note that the Commonwealth Government already offers a subsidy scheme to pensioners that have a Pensioner Health Benefits Card to assist with telephone access charges. This scheme provides pensioners with a $14.80 discount on quarterly telephone access (approximately $60 per year). Therefore, even in the absence of the compensation scheme discussed above, pensioners receiving this existing subsidy would not pay the entire $235 per year access charge proposed under the price rebalancing analysis. If the increase in access charges did result in households discontinuing normal telephone access, households could avail themselves of Telstra's free access service, known as InContact. This service allows households to receive incoming telephone calls but not make any outgoing calls, with the exception of emergency numbers and free Telstra inquiry numbers. There were 40 000 subscribers on the InContact scheme at the end of 1995–96 (Telstra *Annual Report 1996*, p. 22).

On the other hand, the proposed rebalanced pricing structure could potentially increase the proportion of households with access to a telephone. In a study of residential telephone service and prices in New Zealand (Evans 1996) it was found that households appear to choose access on the basis of the price of the bundle of services that access provides, rather than the price of access alone. So although the rebalanced pricing structure increases the price of access, it decreases the price of long-distance and international calls, which for some households may reduce the total price of access and usage, and hence encourage access to the telephone network.

9 INTERCONNECT ACCESS PRICING

Network competition in telecommunications was introduced by allowing Optus to interconnect into Telstra's network, especially for local reticulation of long-distance and international calls (see Chapter 5). There was some history of interconnection prior to network competition — OTC's interconnection into Telecom's network for the completion of its international calls and AUSSAT's use of the Telecom network for the reticulation of private network calls. With respect to Optus's calls, access to Telstra's facilities is regulated and AUSTEL uses what it calls 'accounting separation' to assist it in arbitrating on access and detecting anti-competitive behaviour. From July 1 1997, other carriers will be able to enter and the access regime is currently under review. The chapter gives suggestions for the terms of network access in a post-1997 environment.

As Australian telecommunications has moved from statutory monopoly into progressively greater competition, the importance of the interconnect access issue has increased. With the end of the duopoly in mid-1997, the determination of rules for interconnect access become more important, and are the subject of current debate (ACCC 1997, BTCE 1997).

When Telecom and OTC operated as separate entities, Telecom reticulated all of OTC's calls within Australia. This arrangement had prevailed since OTC's establishment in 1946. OTC paid an interconnect charge for this service. This is the first instance of interconnect in Australia. However, the procedure used appeared more a means of sharing profits from international services than a serious approach to determining interconnection on the basis of public utility pricing principles.

A second area of interconnect opened up in the eighties with the development of private networks based on long-distance circuits leased from Telecom or supplied by AUSSAT. Some of those constructing private networks sought interconnection into Telecom's local network for local reticulation of their calls. Telecom developed a charging structure based on a fixed annual charge per line plus the price of a local call per use. While not without problems, this was a more serious attempt at interconnect price determination.

The importance of access pricing increased with the emergence of network competition following the licensing of Optus. Consistent with experience in other countries introducing network competition, the new participant relied (at least initially) on the incumbent dominant carrier (Telecom) for the local component of its service provision. The development of the relationship between Optus and Telstra, and what it implies for the new competitive regime, are the princpal concerns of this chapter.

9.1 Early Australian experience with interconnect access pricing

International call reticulation by Telecom for OTC

Prior to the amalgamation of OTC and Telecom, domestic reticulation of international traffic from international gateway exchanges was handled by Telecom. Since then the total Australian component of international calls has been handled internally within the merged organisation, now known as Telstra.

Substantial information about the access pricing arrangement was publicly-available until 1988–89. Broadly, Telecom charged a flat rate of at least 20 cents a minute for all international calls it carried. After 1988–89, OTC began supplying less information about its costs, making it impossible to identify how much OTC paid Telecom for access to its network. Since the amalgamation of Telecom and OTC, no quantitative or qualitative information on the internal pricing arrangements is publicly available.

Sources of information about the access regime prior to amalgamation of OTC and Telecom are OTC Annual Reports, Alston (1988), the Industries Assistance Commission (IAC) (1989), the Prices Surveillance Authority (PSA) (1989) and the Bureau of Transport and Communications Economics (BTCE) (1993).

According to the BTCE (1993, p. 51), Telecom charged OTC a ‘flat rate of about 20 cents per minute for the domestic component of the international calls irrespective of the domestic origin or destination of the call, or time of day’. Similarly, the IAC (1989, pp. 149–150) stated that, ‘based on evidence from Telecom, it appears that this charge is a flat 20 cents per minute, irrespective of the domestic origin or destination of the international call, or time of day.’ The Prices Surveillance Authority (1989, p. 12) indicated that the ‘terminal charge is differentiated according to traffic direction (incoming or outgoing) and type of connection (automatic or operator-assisted ...) ...’

It now appears that the average rate paid to Telecom may have been higher than 20 cents, perhaps around 30 cents per minute. OTC’s 1988–89 Annual Report states that it made a $236.3 million payment ‘to Telecom for domestic transmission' (p. 40). On the basis of OTC's bothway total of 785 086 telephone and Telex minutes, this works out at 30.01 cents per minute. Similarly, the PSA (1989, p. 33) calculates an average of 30 cents per minute, but notes that some of OTC's payments to Telecom were lump-sum rather than per-minute.

While Telecom's costs of reticulating calls varied substantially by distance, thickness of route and time of day, the rate charged to OTC was apparently in excess of the cost of even the most costly reticulations, and certainly much in excess of the cost of local reticulations. As Telecom did not operate an international call service, this excess of the interconnect price over the cost of providing it cannot be explained in terms of a payment for lost contribution to overheads by Telecom, as under the ECPR. The most likely explanation is that the payment represented a form of profit sharing by the two carriers.

The access charging regime had implications for both consumer welfare and economic efficiency. If Telecom had applied a cost-based pricing structure, and if this had been passed on by OTC in lower prices to end users, consumers would have gained and economic efficiency would have been enhanced.

Access pricing for AUSSAT and leased line private network traffic

In the case of private network traffic carried long distance by AUSSAT or on a leased line, the interconnect policy developed by Telecom involved a two-part pricing structure and was designed to prevent third-party use of the private network. Private networks were allowed to interconnect at both ends, but traffic was not allowed to go out of and back into Telecom's public network. Traffic entering the Telecom network was charged on a per-call basis at the price of an (untimed) local call. In addition, each connected line was charged an annual fee of between $600 and $3 300, depending on distance. The proportionate scale of charges exactly followed the STD distance-related pricing structure. The structure was later changed to a flat fee of $2 200 per interconnected line, with intrusions into the local network still charged at the local call rate.

The rationale for this pricing scheme was that the fixed cost covered the loss of contribution to CSOs by the diversion of STD traffic into private networks, and that the charge per call reflected the cost of each intrusion into the public network. In the initial version, the fixed pricing structure discriminated against longer-distance private network traffic. The variable component was above per unit cost and did not reflect cost differences between peak and off-peak use of the LEN.

9.2 Access pricing for Optus under duopolistic network competition

The licensing of Optus with carrier status and the coincidental amalgamation of Telecom and OTC simultaneously closed off one experience with interconnect and opened another. Neither of the two previous experiences with interconnection were of much help in guiding the terms under which Optus could interconnect with Telecom. As noted, the access price paid by OTC to Telecom for Australian reticulation appeared more a profit sharing exercise between the two monopoly carriers, while the arrangements between Telecom and private network operators were incompatible with standard public utility pricing principles.

The new arrangements were to be fundamentally different from the older ones in two ways. First, they were to be determined by an independent regulator (AUSTEL) rather than by Telecom. Second, the arrangements were to be guided by an explicit criterion — directly attributable incremental cost (or DAIC).

Initial access arrangements

When network competition in telecommunications commenced, Telecom (now Telstra) was obliged to allow the second carrier, Optus, access to its network for the purpose of reticulating its long-distance and international calls at the local network level. Under the initial competitive regime, the local exchange network was viewed as an 'essential facility' for the final distribution of the second carrier's long-distance and international calls. Optus initially established only its own long-distance network, relying totally on Telstra for local reticulation.

When Optus commenced its plans for entry in 1991, the two carriers could not agree on the conditions of access, and AUSTEL was instructed to report to the Minister on the conditions under which Optus would be allowed to interconnect. The Minister determined that the interconnect agreement was to be determined on the basis of DAIC.

AUSTEL received advice from a variety of sources. Telecom argued for a wholesale price of about 6 cents per minute at each end of the call. The main telecommunications union argued for a similar price. Optus suggested a substantially lower price.[1]

[1] At this stage there were still two consortia vying for the second carrier licence. The other one (Kalori) also argued for a substantially lower price.

AUSTEL's recommendations, released in a three volume report in July 1991, were for an average price somewhere between these extremes, at an average of 3.14 cents per minute per end. There was some slight allowance for differences in costs by region and according to peak and off-peak. The price included an estimate of 'long-run marginal cost' plus a small contribution (0.52 cents per minute) to the cost of the CAN.

King and Maddock (1996a, p. 144) contend that the price determined reflected long-run variable costs. The method AUSTEL used for isolating the costs attributable to the entrant is not totally opaque. However, in effect the estimate of long-run marginal cost (averaging 2.64 cents per minute) is roughly equal to average total cost of the LEN. The estimate of average cost for the LEN in 1995–96 presented in Appendix A is 2.5 cents per minute. In 1991 values, the total cost of the LEN would have been less, but the total number of minutes was also substantially less. On balance, the average cost was probably about the same.

Commercial negotiations between Telstra and Optus

Optus and Telstra have since renegotiated the basic access agreement but the new terms of access have not been published. However, industry analysts broadly agree that the new rate is 3.5 cents per minute, well in excess of the estimate of average cost of the LEN (2.5 cents per minute).

This raises the question of why the price rose rather than fell. One possibility is that Telstra and Optus are positioning themselves for the new competitive regime after mid-1997, by establishing a high base on which the consideration of the rate for new carriers will commence.

There is also a separate interconnect agreement between the two carriers for the carriage of local calls. The agreement has been registered with AUSTEL, but the terms are not publicly available. However, BZW Australia (1996, p. 59) claim that the 'access agreement struck between Telstra and Optus Vision envisages a flat rate interconnection payment of around $0.10 per local call originated on one network and completed on the other network.' This is roughly equivalent to Telstra's average cost per use of the LEN estimated in Appendix B.

Revenues and costs from long-distance operations

After several years of sharing the long-distance market, both Telstra and Optus appear to have revenues well in excess of costs. Consider first the case of Optus. It is estimated that Optus had 1 692 million long-distance minutes (ie

3 384 million interconnect minutes) and 400 million international minutes; giving a total of 3 784 million interconnect minutes in 1995–96 (see Appendix A). At 3.5 cents per minute, this represents a total payment to Telstra of $132 million. It is likely that Optus's long-distance business is quite profitable. It is estimated in Appendix B that Optus has an average price per long-distance minute of 29.3 cents. Optus's cost per minute is the interconnect cost of 7 cents per minute (3.5 cents x 2) plus its average cost of long-distance carriage. If this were the same as Telstra's (estimated as 7.36 cents per minute), Optus's total cost per minute is 14.36 cents, less than half its average price per minute.

Optus's surplus of about 15 cents per minute is substantially lower than Telstra's. Telstra has a higher estimated average price (31.1 cents per minute), and a lower cost of local reticulation (2.5 cents x 2). This leads to a per unit excess of average revenue above average cost of about 19 cents.

Optus's decision to construct its own local network

King and Maddock (1996a, pp. 144–5) have suggested that Optus's decision to construct its own local network may have been influenced by the access price it faced. From a static perspective this does not seem likely. The price paid by Optus for using Telstra's network is, while above the average total cost incurred by Telstra, well below that which would make Optus's long-distance operation unprofitable. It is more likely that Optus's decision reflected uncertainty about the future of access arrangements and the desire to offer other services (such as pay-TV), rather than an excessive interconnect price per se.

Post July 1 1997 access arrangements

The Hilmer reforms (Competition Policy Reform Act 1995) have attempted to develop a general national approach to access, not based on industry-specific regulation. At present the industry-specific body, AUSTEL, acts as the arbitrator on access disputes. In the new Exposure Draft on post July 1 1997 legislation (Minister for Communications and the Arts 1996), where commercial negotiation fails, the ACCC — not AUSTEL — will play the arbitration role.

Under arbitration, the primary focus of the access regime is 'to promote long term interests of end users' and the criteria are supposed to give ACCC 'clear guidance'. The explicit criteria (#260) include (in addition to the long-term interests of end users):

- covering the direct costs of providing access; and

- the economically efficient operation of a carriage service.

The Minister may intervene with guidelines to assist the arbitration process. These will be binding and no access undertaking or agreement in existence could be incompatible with them. This power seems to give the Minister substantial discretion regarding the principles guiding arbitration and, perhaps, the power to determine prices directly.

The long-term interests of end users will not be well-served by an interconnect pricing regime which involves access prices that enable Telstra and Optus to maintain final service prices at or near existing levels — well in excess of costs of provision. The existing retail pricing structure is highly inefficient (Chapter 8), and the setting of access prices on the basis of the ECPR (Chapter 5) would perpetuate the current inefficiencies.

Long-run marginal cost of accessing the LEN provides an efficient basis for setting the access price for the local network. Based on existing technology, this is estimated to be about 2.5 cents per minute (Appendix B). An access price at this level would be compatible with fostering competition without compromising the viability of the two existing carriers.

Both the ACCC (1997) and the BTCE (1997) have argued that the access charge should include a contribution to common costs, as well as the long-run marginal cost of the LEN. In particular, the ACCC identifies (non-usage based) CAN costs as one type of common cost that might be included. However, since CAN costs are not incremental, they do not increase as more service providers gain access to the local network — each additional user would continue to use the same existing twisted pair of copper wires from the subscriber's premises to the nearest pole.

As argued in Chapter 4 and 8, CAN costs are efficiently recovered from subscriber access charges. That Telstra is not doing so currently should not enter the debate on network access pricing. On the contrary, were CAN costs again to be built into the access pricing formula, this would provide a reason (in addition to the price sub-caps) for perpetuating Telstra's currently inefficient pricing of the CAN.

Similarly, recovery of unallocable overhead costs should not enter the debate in access pricing. Instead, these are efficiently covered by Ramsey-Boiteux variations in the prices on final services, depending on the demand characteristics of those services. Indeed, a profit maximising carrier, unconstrained by price sub-caps or social objectives, would have an incentive to adopt this type of pricing structure. For a forward-looking carrier with strong enough price advantages, such Ramsey-Boiteux pricing would also provide protection against inefficient entry (Baumol, Bailey and Willig 1977). Thus, carriers do not lack incentives to adopt efficient methods of recovering common costs via their retail prices. Recovering them instead through network access charges would again perpetuate current inefficiencies.

Finally, the funding of USOs and CSOs should not enter the debate on network access pricing. These should be recovered from the budget. Including their funding in the discussion of access pricing diverts attention from the appropriate policy choices.

9.3 Conclusion

The introduction of network competition in 1992 gave rise to a requirement for 'interconnect' or 'access' pricing of the new carrier's use of the existing carrier's local network. This introduced a 'wholesale' element into the pricing considerations. Depending on conditions in the markets for final services, the access price may influence the prices of these retail services. Because of the potential importance of the access price to economic efficiency, it has excited substantial practical and theoretical interest.

Suggested bases for efficient access pricing have ranged from some concept of the access provider's long-run marginal cost of providing access to the LEN, to Baumol and Willig's efficient component pricing rule. The former is a lower bound to the price that might be charged and was loosely the basis on which Optus was granted access to the then AOTC's local network in 1992. The latter is an absolute upper bound, including long-run marginal cost but also taking into account the incumbent's opportunity costs of lost contribution to overheads and profits.

Under existing arrangements, Optus has been able to gain about 15 per cent of the long-distance market and around 23 per cent of the international call market. Optus and Telstra have apparently not engaged in aggressive price competition in these markets as there is still a large gap between prices and costs. The new access regime should not do anything to help hold up long-distance and international call prices. Nor should it undermine the financial viability of the existing carriers. A rate of about 2.5 cents per minute would satisfy these twin objectives. Inclusion of CAN costs, overhead costs or USO/CSO contributions into the access pricing formula would distract attention from more efficient ways of recovering those costs and merely perpetuate current inefficiencies.

10 INSTITUTIONAL STRUCTURE FOR COMPETITION

Through all the changes to Australian telecommunications in the last twenty years, the structure of the established and dominant telecommunications carrier (Telstra) has changed considerably. However, in spite of these changes, Telstra still has a vertically integrated structure with no internal accounting division. Is this the appropriate structure for Telstra as the new competitive regime approaches?

The prime purpose of this chapter is to evaluate the existing organisational structure of Telstra and its interaction with the associated regulatory system. Evaluated on the basis of standard notions of economic efficiency, there are three areas of possible difficulty with the existing structure:

- conflict of interest between Telstra's different roles;
- inefficient pricing of use of the local exchange network; and
- facilitation of collusion between Telstra and Optus on the pricing of final products.

One approach to reform would be an internal restructuring of Telstra into distinct self-supporting businesses with clear commercial objectives and strict arms-length commercial relationships with one another. This could have marginal benefits with respect to all three problem areas identified, although there could still be problems while Telstra remained under a single board.

A second approach would be a complete break-up ('divestiture') of Telstra into at least two (and possibly three) totally separate enterprises, each with a separate board: two network enterprises (the local network and the rest of the network) and a services enterprise. The services enterprise could naturally be sub-divided, perhaps along the lines currently emerging in Telstra. In addition to addressing all three problems, this could form an alternative basis for the dilution of government ownership.

10.1 Existing structural arrangements

Telecom/Telstra's structure has changed considerably in the years following the splitting of postal and telecommunications services in 1975. It has progressively been subjected to more competition, been corporatised, and assumed more functions (partly through technological change and partly from the amalgamation with OTC). It has moved from what was still a state-based management structure to one based more on functions, and there is an evolving division of network functions from service provision.

The pace of change has accelerated greatly in recent years. Telstra's structure was spelt out in detail in the 1994–95 *Annual Report* (pp. 14–15), with five groups: three operational (commercial and consumer; corporate, international and enterprises; and network and technology) and two supporting (finance and administration; and employee relations). By early 1996, the structure had reportedly changed again (BZW Australia 1996, pp. 28–31) with four business units, a products group and a corporate centre with three branches. Yet another structure is set out in Telstra's 1995–96 *Annual Report* (pp. 32–33). There are now four operational groups (broadly the three listed in 1994–95, with some rearrangement of functions, plus a retail products and marketing group), one subsidiary (Telstra Multimedia) and three support groups (the two listed for 1994–95 and a new regulatory and external affairs one). The detailed functions of these groups is spelt out in Chapter 6.

These Groups do not operate as separate businesses in the sense of being profit centres, nor are the relationships between them at 'arm's length', governed by an explicit internal transfer pricing mechanism. AUSTEL has developed a model of what it calls 'accounting separation', involving confidential product-based financial statements through the COA/CAM, which assist AUSTEL in arbitrating over disputes involving interconnection into Telstra's local network. This is not really accounting separation, as it has no implications for transfer pricing or performance evaluation within Telstra. Telstra's own financial accounts are presented on a highly aggregated basis, and while the COA/CAM accounts produced for AUSTEL are disaggregated — by access, local, STD, IDD, mobiles and leased lines — there is no evidence of any internal transfers between those categories. For example, there does not appear to be any attribution of the cost of local reticulation service to the STD and IDD services, nor payment for the local reticulation costs incurred.

10.2 Difficulties with the existing structure

Possible conflict of interest

Telstra's dual role as a supplier of access and a competitor with those gaining access may lead to a conflict of interest. While Telstra benefits directly from supplying access as long as the price it receives exceeds the full cost of provision, it loses to the extent that this leads to a reduction in profitable business for the final product. This is likely to be a typical situation in those instances where it is forced to allow (rather than volunteers) access to a competitor.

The problem seems to be particularly important to service providers that interconnect according to the 'National Connect' policy determined by Telstra. AUSTEL's (1995b) study on service providers revealed many difficulties. In its 1995–96 *Annual Report*, AUSTEL summarised the issue noting that:

> Carrier vertical integration was the predominant concern of the majority of non-carrier associated service providers ... in particular the need for policies and a framework of practices to govern 'downstream' involvement of carriers in VASs. (p. 20)

The National Frame Relay tariff issue provides another case in point. Frame relay is a high speed digital data service introduced in 1995. It is marketed directly by Telstra and indirectly through service providers such as BT and AAPT. This is a case where there is an apparent conflict of interest, and represents a possible instance of predatory anti-competitive behaviour. Telstra was alleged to have charged service providers a higher price for the National Frame Relay product (marketed wholesale to them as 'DDS Fastway') than it charges its direct customers. AUSTEL found this practice was anti-competitive and disallowed the tariff in June 1996. Nonetheless, Telstra has been able to continue the tariff, prompting strong criticism from service providers (Helen Meredith, 'SPs fed up over Austel's delays with frame relay', *Australian Financial Review*, 7 October 1996).

As a general approach, 'accounting separation' reduces the scope for anti-competitive conduct of this kind, but 'it treats the symptoms of the problem and does not change the incentives' (IC 1996, p. 87). That is, there is still an incentive to behave in an anti-competitive manner, but less ability to get away with it.

Inefficient pricing of the local exchange network

The pricing of use of the local exchange network currently depends variously on the type of use and the identity of the user.[1] Only one category of use —

[1] The LEN is the set of equipment for switching and inter-exchange carriage of telecommunications traffic. The LEN carries local call traffic as well as reticulating higher level traffic (eg long-distance calls) into and out of the CAN. The LEN and the CAN together make up the 'local network'. The question of access pricing does not

Optus's use for purposes of reticulating its national and international long-distance calls — is in any way consistent with the rules for efficiency coming from the public utility pricing and investment literature discussed in Chapters 4 and 5. This inconsistency is likely to mean both inefficient use of the network and inappropriate signals for development of the local exchange network.

Use of the local exchange network is based on at least four different pricing regimes.

First, there are the arrangements between Telstra and Optus for reticulating Optus's long-distance and international calls which involve time based charging, possibly varying between the peak and the off-peak and with location. These are loosely based on the long-run marginal costs (that is, including capital costs) of the access.[2]

Second, while the circumstances are unclear, it is unlikely that Telstra pays/charges itself for interconnection of its long-distance and international calls into the local exchange network on the same basis as Optus is charged. Indeed, there are some indications that it does not have any explicit mechanism for pricing its own use. For example, prior to the amalgamation of Telecom and OTC, Telecom charged OTC on an explicit basis (a flat rate of about 20 cents per minute), but there now appears to be no internal pricing mechanism in the merged organisation.

Under its new access pricing principles, the ACCC (1997) intends to compare negotiated access prices with the price an incumbent charges itself for the same service, hence establishing a clear requirement for an internal pricing mechanism. However, the ACCC notes that its 'rules of thumb' do not involve comparing these prices with costs. So long as the different divisions of Telstra remain under a single CEO and Board of Directors, there would be an incentive to manipulate the internal transfer price.

Third, not only are the conditions of Telstra's and Optus's use of the local exchange network for reticulation of higher level calls almost certainly different from one another, those applying to subscriber local call use are different again, with subscriber calls being untimed for charging purposes and having no locational or peak/off-peak distinctions.

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arise for the CAN because CAN costs are recovered efficiently via subscriber access charges (see Chapter 4).

2 There are separate arrangements between the carriers for other instances of access including for local calls, analogue cellular access and digital cellular access. For analogue cellular services, Optus acts as a service provider, piggy-backing on Telstra's service.

Fourth, there are separate interconnection arrangements for service providers. Under Telecommunications (Interconnection and Related Charging Principles) Determination No. 1 of 1991, carriers get 'more favourable' charges when interconnecting, and SP interconnect charges are based on commercial negotiation. The National Connect product available to SPs has characteristics similar to the interconnect policy used by Telecom for private networks (see Chapter 9), in that it is determined by Telstra, it involves non-use related fees, and the use price is related to the retail price rather than the cost (AUSTEL 1995b, pp. 32, 39, 54 and 78–79).

Efficient pricing of, and investment in, the local exchange network is unlikely to be compatible with the existence of four or more different pricing regimes for use of the same network. Efficient pricing of the local exchange network requires that all uses be set equal to marginal cost of providing the service (including the cost of peak load-specific equipment for peak uses) and that, where this does not result in complete cost recovery, that the deficit is retrieved from access charges.[3] Use prices would vary distinctly over the demand cycle.

It is likely that the peak load capacity of the local exchange network is inefficiently high because of the absence of timed local call charging. On the other hand, excessive final prices for domestic and international long-distance calls would mean less than optimal demand for these uses of the local exchange network. The balance of these two effects on the capacity of the network is an empirical issue.

Collusive behaviour

The existing structure may be conducive to collusive behaviour between Optus and Telstra, supporting monopoly pricing. Where the access provider is vertically integrated, the commercial negotiations between it and its product market rivals provide an opportunity for discussing price and output. Contact of this kind would not normally be allowed. However, the possibility of this type of anti-competitive behaviour was not an issue in the Department of Communications and the Arts' (1994) issues paper, *Beyond the Duopoly*, and does not appear to be addressed in the commentary to the draft legislation (Minister for Communications and the Arts 1996).

Ivor Ries ('The Telecom consumer case', *Australian Financial Review*, 17 September 1996) refers to what he sees as the 'established Telstra-Optus oligopoly' and comments that Telstra's 1995–96 profit of $2.3 billion showed

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[3] Access charges could vary over different demands for access according to the Ramsey–Boiteux principle.

'just how cosy the Australian telecommunications oligopoly has been for the past few years'. Quiggin (1996, p. 130) claims 'that price reductions have been almost exactly equal to the minimum required under price cap regulations suggests that competition has had little overall effect on ... prices' and 'that on average the prices offered by the two firms [Telstra and Optus] are quite similar'.

As shown in Chapters 8 and 9, both Telstra and Optus continue to have long-distance prices that are well in excess of costs, and the margins are inefficiently high. However, this is not necessarily a consequence of collusion, even in part. As also shown in Chapter 8, the price capping provisions to some extent place a floor under Telstra's STD prices by preventing other prices from rising through strict sub-caps. Nevertheless, such sub-caps can become a focal point for tacit collusion (MacAvoy 1995).

10.3 Approaches to reform

Division of Telstra into arms-length businesses ('ring-fencing')

Telstra's organisational structure has been improved by rapid progress towards a rational separation of infrastructure and service provision. The next step would be to establish these divisions as profit centres with specific objectives and arms-length commercial relationships with one another through a commercially-based internal pricing mechanism. This would provide internal benefits by establishing a clearer objective focus for management and staff — performance would be more clearly measured and a closer relationship between outputs and inputs established. The entire organisation would remain under common ownership.

Consider how this would affect performance in the three areas identified.

First, there is likely to be at least some advantage with respect to reducing anti-competitive conduct. The LEN division of Telstra would not benefit commercially by favouring other Telstra businesses over external ones, although the overall organisation still could. This means that the reduction in anti-competitive behaviour would be related to the extent to which decentralisation of management and adequate internal transfer pricing were fully implemented. Since the organisation would still be under a single CEO and Board of Directors, management decisions and internal transfer pricing could still be manipulated in an anti-competitive way.

Second, there is likely to be an advantage regarding pricing use of the LEN (subject to the proviso just made). However, regulatory influences on pricing (sub-caps in particular) could mean that the overall price structure continued to lack coherence.

Third, collusion would be less of a problem. Potential rivals would deal directly with the LEN division, and there would be less reason for other divisions to be involved in those negotiations.

Divestiture

The difficulties with internal division under single ownership intrinsically relate to common ownership. Managers must act to further the interests of the corporation as a whole. The interests of the organisation as a whole could conflict with those of the separate businesses, resulting in possible tensions in addressing all three problems with the existing structure. This leads to the conclusion that separation of ownership of the divisions is necessary to achieve the maximum possible gains from structural reform.

A 'vertical separation' model of this kind was favoured by the Independent Committee of Inquiry into National Competition Policy (Hilmer 1993). It could also provide internal benefits to the organisation. Telstra is (after BHP) Australia's second largest commercial organisation under a single board. Whether an organisation is 'too big' depends not so much on overall size but on how it is organised and whether there are economies from having the functions performed together ('economies of scope'). Telstra's current organisational structure may be inappropriate for its size.

Two difficulties with such vertical separation have been identified.

First, it could lead to 'double marginalisation', where splitting a monopolistic vertical production chain into separately-owned upstream and downstream production units results in a higher price and lower output than under single ownership. However, this is unlikely in the circumstances of Australian telecommunications where regulators have detailed knowledge of cost structures of providing both local and long-distance services, and where some degree of competition is emerging at both levels.

Second, the usual justification for a vertically integrated structure lies in the belief that there are economies of scope from having the different functions within a single organisation. King and Maddock (1996a, pp.88–91 and Ch. 8) express some reservations about vertical separation of public utilities in general, including the loss of economies of scope. In telecommunications, there may be economies from operating local and long-distance services within a single organisation. However, the source of the cost savings from joint operation of these services is not apparent. Further, in Australian telecommunications it is possible that excessive size has also led to diseconomies. Economies of scope have not been important in past decision making about Australian telecommunications; especially the decision to allow the entry of Optus. Were they apparent, their loss would have to be set against the benefits of vertical separation.

10.4 Conclusion

Three possible areas of inefficiency have been considered with respect to the existing arrangements for Telstra providing access to its rivals as well as to itself. These are anti-competitive conduct, inefficient and inconsistent use of the LEN, and retail product market collusion.

AUSTEL's so-called 'accounting separation' — involving confidential product-based financial statements through the COA/CAM — assists marginally with respect to the first and second of these, by providing information which may help in the identification of anti-competitive behaviour and in guiding the determination of interconnect access prices. However, this division is strictly for regulatory purposes, and does not reflect any other use of the accounts within Telstra.

Formation of arms-length business divisions of Telstra with clear commercial objectives would be a sounder basis for the further liberalisation of Australian telecommunications. One of these would supply access and local switching on a commercial basis to other parts of Telstra and to other carriers and service providers. This could have marginal benefits with respect to all three problem areas with the existing environment.

US-style divestiture, where the local network was separated off under independent ownership, would be a superior approach to all three problems. While there is no strong evidence that either problem is likely, divestiture could present difficulties with respect to double marginalisation and the possible sacrifice of economies of scope. Further, this option may have been partially closed off by the passage of legislation that will lead to the sale of one-third of Telstra.

APPENDIX A: DEMAND STUDIES

A.1 Customer access

Perl (1984)

The Perl (1984) demand study used data from the 1980 Public Use Sample of the 1980 US Census. The analysis used a logit framework in which the probability of having a telephone service was related to price variables, household characteristics and area characteristics. The price variables included in the model estimation were the flat rate price (access and calling price) in flat rate only areas, the flat rate access price in areas with a measured option, the measured rate access price and the measured rate calling price. In addition, the installation charge was also included as a predictor. Perl (1984) summarised the results of his study as follows:

- The study suggested that there had been a substantial increase in demand for telephone services between 1970 and 1980. As a result, increasing access prices in 1984 would have had a smaller effect on access demand than indicated by his earlier study (Perl 1978). The elasticity of demand for access with respect to the access price was estimated from the 1984 model to be about 60 per cent of that derived from the 1978 model.
- Access demand was primarily a function of minimum rather than average access charges. This result suggested that the provision of a low priced access option could have been expected to maintain relatively high levels of access demand even in the face of substantial increases in the prices of the standard service.
- However, demand also depended on local calling prices and even at very low access prices some households would not subscribe to the telephone service unless they could make a large number of local calls at low prices.
- There had been a marked narrowing in income related differences in telephone penetration (percentage of households with phones) between 1970 to 1980. Nevertheless, there was still significant disparity in penetration between the lowest and highest income households, and this disparity would widen if prices increased markedly.

Perl's (1984) logit estimation indicated that the price of access had an expected negative effect on the probability of having a telephone, while income, age, education and size of household had positive effects. Households with a female head were more likely to have a telephone than households with a male head. Unemployment or absence from the labour force reduced the probability of having a telephone as did having English as the non-primary language. In addition, urban households were more likely than rural households to have a telephone. All access prices, household characteristics and area characteristics identified above were found to be statistically significant.

Perl (1984) calculated some representative access price elasticities for different penetration rates and different flat rate and measured rate access charges (Table A.1). While small in absolute value, the elasticities of demand for access were found to increase sharply with the level of access prices and decrease sharply with the level of telephone penetration.

One of Perl's most interesting findings was that the value of having a telephone appeared to increase between 1970 and 1980. Holding all other factors constant, households appeared willing to pay more to have a telephone in 1980 than in 1970. Perl mentions several factors that could have led to the increased value of telephone service: increased prices for other forms of communication, reduced long-distance toll rates, increases in the number of services available by phone and an increased need for the phone as a source of security.

Table A.1: **Price elasticities of demand for access at alternative access prices and telephone penetration rates**

Telephone penetration rate (%)	*Monthly access price*	*Price elasticity*[a]
88	$10 flat rate or $6 measured rate	-0.065
88	$20 flat rate or $16 measured rate	-0.131
88	$30 flat rate or $26 measured rate	-0.196
93	$10 flat rate or $6 measured rate	-0.038
93	$20 flat rate or $16 measured rate	-0.076
93	$30 flat rate or $26 measured rate	-0.114
97	$10 flat rate or $6 measured rate	-0.016
97	$20 flat rate or $16 measured rate	-0.033
97	$30 flat rate or $26 measured rate	-0.049

a The t-ratio for the coefficient on flat rate access price was 2.50 and the t-ratio for the coefficient on measured access price was 2.13.

Source: Perl (1984)

Taylor and Kridel (1990)

The Taylor and Kridel (1990) study aimed to resolve an important problem that arose in the Perl (1984) study. Perl (1984) used the 1980 Public Use Sample which provided over 80 000 observations. While this large sample size clearly provided benefits for model estimations, there was a problem with nondisclosure. To forestall the identification of any individual household, the Census disclosed place of residence only for areas with a population of at least 100 000. This created a major problem in matching rates with households, as in virtually all cases areas of 100 000 or more population contained several wire centres. Since the rate data referred to wire centres, this meant that it was impossible with the Public Use Sample to get an accurate matching of households and rates. The consequences of this may not be important when the focus is national, but problems emerge where attention shifts to specific socio-demographic groups and areas (Taylor and Kridel 1990).

Taylor and Kridel (1990) aggregated US Census data to the level of a census tract to provide a better match between rates and place of residence. The model estimated was similar to Perl's (1984) but with an extension that took into account differences in the distribution of income across census tracts. The model was developed at Southwestern Bell for use in estimating the impacts of higher local service rates on residential customers. The results corroborated existing views concerning the price elasticity of residential access demand. The study also confirmed the Perl (1984) findings with regard to the importance of socio-economic characteristics, but provided a better vehicle for quantifying specific effects.

Taylor and Kridel (1990) found that while the impact of increasing access charges was small, it was not zero. They estimated that a doubling of access charges across the five states they examined would have reduced penetration from 92.5 per cent to 88.8 per cent. This equates to an elasticity of demand for access of -0.037 with respect to the access price. Taylor and Kridel (1990) did not report the t-ratio for the access price coefficient as 'it could not be obtained directly due to the method used for estimating the coefficient'. They found that low-income, non-white and rural groups would be the most affected, in terms of demand for access, by an increase in access charges. The t-ratios for the socio-demographic variables indicated that they were statistically significant.

Cain and MacDonald (1991)

The Cain and MacDonald (1991) study emerged out of concern that changes in telephone pricing structures and regulatory policies in the 1980s may have altered price elasticities of household demand for access to the telephone system. Using 1987 data, Cain and MacDonald (1991) investigated the determinants of household demand for telephone access. They related household telephone possession to household demographic characteristics as well as several prices (access, usage and connection charges) that influenced the decision to have a telephone.

Cain and MacDonald (1991) employed a logit framework and used data on household characteristics from the March 1987 US Current Population Survey which was based on a random sample of over 58 000 households. Their results indicated that demographic characteristics had a strong effect on penetration rates, in particular income was positive and highly significant. Coefficients on key price variables were negative as expected, statistically significant and small enough to indicate that demand was quite inelastic. In particular, Cain and MacDonald (1991) found:

- in cases where a flat rate applied for access, a $10 increase in the monthly flat rate would result in a decrease in the subscription rate from 0.93 to 0.81, while a $10 increase in the monthly measured service access charge would result in a fall in the subscription rate to 0.84;
- the estimated changes were not constant across demographics — larger falls in subscription rates occurred for consumers with lower incomes, those who lived in the city centre, those from non-English speaking backgrounds and those who were younger; and
- increases in flat rate charges had no significant effect on demand for access when a local measured service was available.

These findings led the authors to conclude that non-traffic sensitive costs could be shifted to local charges from long-distance charges without discouraging universal service. This could be achieved by raising flat rates, expanding local measured service and offering low priced access through budget and lifeline measured service options.

Evans (1996)

Evans (1996) examined residential telephone subscription rates and prices in New Zealand over the period 1986 to 1995. The author observed that over the period 1986 to 1995, the nominal monthly rental price of a residential line increased from NZ$15.06 to NZ$27.22. Over the same period, the price of the 1995 bundle of calls and access for residences and businesses fell in real terms by approximately 50 per cent.

Evans found that, although access prices had increased substantially over the last ten years in New Zealand, there was very little variation in telephone penetration rates. Even broken down by income quartiles, Evans found that New Zealand Telecom's price rebalancing did not precipitate a reduction in subscribership, even among households in the lowest income quartile. Evans concluded from his analysis that households based their access decision on the price of the bundle of services that access provides rather than the price of access alone.

Bodnar, Dilworth and Iacono (1988)

In 1987, Bell Canada petitioned the Canadian Radio-television and Telecommunications Commission for permission to begin a 'rebalancing' of telephone rates. Long-distance rates would be reduced while local rates would be increased. In anticipation of concerns that higher local rates would cause a substantial number of households to give up telephone services, Bell Canada (Bodnar et al 1988) developed a model of residential access demand that could be used to predict the impact of the proposed rate rebalancing.

The Bodnar et al (1988) study was based on household survey data from 1985 collected by Statistics Canada. Data on 34 168 Canadian households were used in the estimation process. A logit framework, similar to that used by Perl (1984), was employed in which the probability of having a telephone service was related to a range of economic, socio-demographic and regional variables.

The estimated coefficients for the variables in the model indicated that the probability of having a telephone varied negatively with price and positively with income, age and education. Single male-headed households were less likely to have a telephone than other types of households and those who rented were less likely to have a telephone than those who owned their own homes. The t-ratios for the coefficients on price, income and all other demographics indicated that these variables were statistically significant.

Bodnar et al (1988) calculated a variety of price elasticities. For Canada as a whole, calculated at the 1985 penetration rate (98.2 per cent) and the 1985 access price, the price elasticity of demand was estimated to be -0.009. By province, the elasticity varied from -0.030 to -0.005. The size of the price elasticity decreased (in absolute value) with size of urban area, age and income. For Canada as a whole, the elasticity for households residing in cities of 500 000 or more was only half the elasticity for households living in rural areas. Therefore, the study concluded that the most vulnerable to rate rebalancing would be the young, low-income, rural households.

When comparing the Bodnar et al (1988) study with the Perl (1984) and Taylor and Kridel (1990) studies, the most notable difference is the relative strengths of the price effects. However, it does not follow from this that price is more important in the United States than Canada. The difference simply reflects the fact that penetration rates are higher in Canada than in the United States — the overall penetration rate is about four percentage points higher in Canada. When calculated using the 1980 US penetration rate of 93.4 per cent and 1985 Canadian values for all other variables, the price elasticity in the Bodnar et al (1988) model turns out to be -0.034.

Madden, Bloch and Hensher (1993)

Madden et al (1993) developed a model for conducting telecommunications stated-preference pricing experiments to enable the evaluation of consumer response to alternative rate structures. The estimation of the model required paired household subscription-calling and rate data which were not available by distance-time band. To overcome this problem, Madden et al (1993) surveyed 175 Australian households that were randomly drawn from the telephone directory.

They used a logit framework in which the probability of a household subscribing to the telephone network was explained in terms of factors that reflected the household's utility from telephone services and its ability to pay for the services. In addition to call-minute prices (cents per minute), Madden et al (1993) included a range of socio-demographic variables in the estimation of their equation including household income (net of the phone rental price), total number of persons in the household, number of children under 14 years of age, the number of persons aged 15 to 24 years residing in the household, ownership of the home, employment status of the head of the household and the age of the head of the household. However, by including the access charge only through the income variable, Madden et al (1993) are presupposing that some sort of access will occur, and are likely to have understated one of the important determinants of access in an ex ante sense.

Only one of the thirteen price elasticities of demand (over various distance-time calling bands) for access estimated by Madden et al (1993) was found to be significant at the 5 per cent level. This was for the distance-time calling band 'Day 0-10 km'. The value of the elasticity of demand for access was estimated to be -0.003 with respect to the price of calls in cents per minute. None of the socio-demographic parameters were significantly different from zero at the 5 per cent level. However, the hypothesis that, as a group, the socio-demographic variables do not add to the explanatory power of the model, was rejected at the 5 per cent level.

A.2 Local calls

Park, Wetzel and Mitchell (1983)

Park et al (1983) examined the effects on local calling of a mandatory switch from a flat rate to a measured rate service. The analysis was based on data generated in the US GTE (GTE is the largest US based local telephone company) local measured service experiment that was conducted between 1975 and 1979 in three small exchanges in Illinios. In May 1975, GTE began recording information on individual customers' telephone use under the flat rate tariffs that were in effect in those exchanges. On 1 September 1977, GTE switched to measured service tariffs and continued to record use information. In contrast with usual practice when measured service plans are implemented, the experimental tariffs were non-optional and included no call allowance. Thus, this study has some significance for the Australian situation where a measured rate service (in terms of number of calls) exists and there is no option for flat rate tariffs or call allowances.

The estimated elasticity of demand for the number of local calls was -0.08 with respect to a per-call charge, and -0.06 with respect to a per-minute charge. The elasticity of demand for the number of local call minutes was estimated to be -0.09 with respect to a per-call charge, and -0.11 with respect to a per-minute charge. The coefficients for each of the four price elasticities were found to be statistically significant.

Bidwell, Wang and Zona (1995)

Bidwell et al (1995) presented a theoretical model of asymmetric demand response to price change for local telephone calls based on both classical demand theory and prospect theory. They estimated the parameters of the specified model using data from selected pages of monthly telephone bills dated January 1989 through to October 1993 of 128 billing numbers in New York City. Bidwell et al (1995) reported that during this period, prices changed twice, first at the beginning of 1991 and again at the end of 1992. Prices went up in some call categories and down in others. In the 1991 price revision, the allowance which provided customers with a certain value of calls free of incremental charges was removed. The bills enumerated, among other things, the number of calls that were made to various destinations and the total charges for each of these groups of calls.

The parameter estimates were used to construct long-run and short-run price elasticities of demand. The parameter estimate for price was found to be statistically significant. The average customer's long-run elasticity of demand for the number of local calls was found to be -0.04 with respect to the price per call. The short-run elasticity estimates revealed an asymmetric demand response: the average elasticity of demand for the number of local calls over the first year following a per call price decrease was -0.02 while the average elasticity of demand for the number of local calls over the first year following a per call price increase was -0.22. These results supported the authors' predictions that customers react more quickly and strongly when prices go up than they do when prices go down.

Trotter (1996)

Trotter (1996) examined the demand for local telephone calls in the United Kingdom using data from the Kingston Communications (Hull) company over the period 1968 to 1987. The dependent variable in his analysis was the number of local calls and the explanatory price variable was price per call. When no other explanatory variables were included, the price elasticity of demand was estimated to be -0.04. When other explanatory variables were included, the absolute value of the price elasticity was lower (due to the positive correlation between the explanatory variables). Trotter (1996) did not report the t-ratio of the price coefficient, but noted that it was not significant at the 5 per cent level.

Madden, Bloch and Hensher (1993)

Madden et al (1993) estimated demand equations for local call minutes as a function of alternative call-minute prices using a seemingly unrelated regression (SUR) system. The data used for the model estimation were the same as those described above in their customer access study. The only statistically significant elasticity of demand for local call minutes with respect to cents per minute was for the distance-time calling band 'Night 10-30 km' and was estimated to be -0.46. However, this elasticity estimate cannot be interpreted as the elasticity of demand for an Australian local call. The price for a local call in Australia is not dependent on a time-distance calling band or the number of minutes of use.

A.3 Long-distance calls

Duncan and Perry (1994)

Duncan and Perry (1994) estimated intraLATA toll demand elasticities. IntraLATA toll calls travel beyond the local area but within a LATA. Monthly intraLATA time-series data from July 1986 to November 1990 for California were used to estimate an autoregressive-distributed lag model, where the long-run elasticities were parameters estimated in a nonlinear system. Over the period examined, the only price variation came from a single rate change in 1988 and 18 explicit changes to the surcharge. Duncan and Perry (1994) found the long-run demand elasticity measured in terms of intraLATA revenue and minutes of use of intraLATA calls to be -0.38 with respect to the intraLATA toll price. The t-ratio for the price coefficient was 4.7 indicating that the estimated price elasticity of demand was statistically significant.

Gatto, Langin-Hooper, Robinson and Tyan (1988)

Gatto et al (1988) presented an econometric model of interLATA-interstate switched access demand. The model was estimated in a state-level pooled cross-sectional time-series framework, using data filed by US local exchange companies. Gatto et al (1988) estimated the long-run elasticity of demand for minutes of access to the interLATA service to be -0.72 with respect to the price of a minute of use. With a t-ratio of 17.7, this price elasticity was found to be highly significant.

Madden, Bloch and Hensher (1993)

Madden et al (1993) jointly estimated long-distance (over 30 km) call demand equations using a SUR system. The data used for the model estimation was the same as that described above in their customer access study. The own-price elasticities of demand for long-distance minutes with respect to cents per minute ranged from -0.53 for the shortest distance-time calling band of ‘Day 30-100 km’ to -1.01 for the longest distance-time calling band, ‘Economy over 800 km’. However, none of the own-price elasticity estimates were found to be statistically significant.

Train (1993)

Train (1993) presented estimates of the elasticity of residential demand for intraLATA toll service using a discrete choice model of use demand by residential customers in Delaware in 1985. Train allowed for two service options in his model: a flat rate service that provided unlimited local calls without additional charge, but levied use charges for intraLATA calls; and an extended area service that provided unlimited calling in both categories, but with a higher monthly fixed charge. Since customers under the extended area service faced zero prices, a reduction in intraLATA rates did not affect the prices that they faced, so that their elasticity was necessarily zero. The elasticities for customers under the flat rate service were estimated to be -0.42 for number of minutes of intraLATA calls and -0.34 for number of intraLATA calls with respect to price per minute. The average across all customers (extended area service and flat rate service) was found to be -0.39 for total minutes of intraLATA calls and -0.31 for number of intraLATA calls (with respect to price per minute).

Train (1993) also compared his results with those of several other studies. Zona and Jacob (1990) reported an elasticity of -0.47 for residential customers of United Telecommunications using cross-sectional methods. Doherty (1984) estimated elasticities for residential intraLATA toll demand of -0.27 in the short run and -0.29 in the long run in his time-series study of New York Telephone Company demand. Taylor, Rappoport and Michels (1993) found elasticities ranging from -0.40 to -0.42 using regression procedures on customer-level data from several local exchange carriers. Duncan (1992) found an intraLATA toll elasticity of -0.38 for business and residence combined using time-series data. Given that the elasticity for business customers is lower than that for residential customers, the residential elasticity implicit in Duncan's (1992) study is greater than -0.38 in magnitude. Train (1993) concluded that, with the exception of the older study by Doherty (1984), the estimates obtained from his model and those obtained by other analysts indicated that the residential elasticity for intraLATA toll was around -0.40.

Bureau of Transport and Communications Economics (1991)

The BTCE (1991) used its Telecom trunk calls equation to model the price elasticity of demand for the number of long-distance calls. The BTCE (1991) estimated that the elasticity of demand for number of long-distance calls was -0.93 with respect to the long-distance tariff rate. The t-ratio on the tariff rate was 6.2.

Martines-Filho and Mayo (1993)

Martines-Filho and Mayo (1993) estimated the price elasticity of demand for intraLATA calls. The authors estimated three models using OLS and feasible generalised least squares and 1989 data for four major US metropolitan areas. The only difference between the three models was differing parameter structures. The first model allowed variations in the intercepts for certain coefficient values but restricted them to be constant over time. The second model allowed for cross-sectional differences on the slopes associated with a specific set of regressors while holding the intercept fixed. The third model allowed for variations on both the intercepts and the slope coefficients.

Martines-Filho and Mayo (1993) reported that, consistent with their expectations, the coefficient on the price variables were negative and highly significant (t-ratios ranged from 4.9 to 21.5 for the different models). The price elasticities of demand for number of intraLATA calls generated by their estimations ranged from -1.05 to -1.55 (for the three models) with respect to the price paid for a call. While Martines-Filho and Mayo (1993) acknowledged that their price elasticity estimates were higher than those estimated by other studies, they did not provide an explanation for the difference.

Appelbe, Snihur, Dineen, Farnes and Giordano (1988)

Appelbe et al (1988) developed a number of models of demand for Telecom Canada telephone calls to the United States. The models were developed primarily to evaluate the revenue impacts of proposed tariff changes by one or more Telecom Canada member companies. The methodology for the study was based on the modelling of point-to-point traffic flows between companies. These pairs of one way traffic flows each form a system of simultaneous equations which are pooled together over groupings of companies. There were six such company groupings for the long-distance Canada models representing short-haul, medium-haul and long-haul traffic for both customer-dialled full-rate and discount-rate message toll services. Pooled time-series/cross-sectional analysis was used to estimate these models.

The authors noted that while this pooled, point-to-point approach introduced considerable complexities into the modelling process, it also allowed for the efficient use of heterogeneous, region-specific data. Furthermore, point-to-point models provide unique information on uni-directional price elasticities (the elasticity of demand for Company A with respect to a price change for traffic originating in Company A) and bi-directional price elasticities (the elasticity of demand for Company A with respect to simultaneous equal percentage price changes for traffic originating in both Company A and Company B). The estimated price elasticities of demand, measured by price deflated revenues (revenues over each specific route divided by the corresponding price index), with respect to price per minute are presented in Table A.2.

Table A.2: **Elasticities of demand for long-distance services with respect to price per minute**[a]

	Uni-directional price elasticity	*Bi-directional price elasticity*
Full rate: short haul	-0.21	-0.36
Full rate: medium haul	-0.35	-0.48
Full rate: long haul	-0.48	-0.73
Discount rate: short haul	-0.39	-0.59
Discount rate: medium haul	-0.48	-0.70
Discount rate: long haul	-0.49	-0.75

[a] T-ratios for the underlying elasticities ranged from 2.5 to 12.6, indicating that all the estimates were statistically significant.

Source: Appelbe et al (1988)

A.4 International calls

Hackl and Westlund (1996)

Hackl and Westlund (1996) investigated the price elasticity of the demand for telecommunications between Sweden and three destination countries: Germany, the United Kingdom and the United States. The model used in the empirical analysis was a linear demand function. The analysis used monthly data over the period 1976 to 1990 which were made available by Swedish Telecom. Hackl and Westlund (1996) estimated their model under both a constant parameter framework and using recursive estimation techniques to test the theoretical assumption that price elasticities of demand vary over time.

Under the constant parameter framework the price elasticities of demand for international telecommunications services, measured in thousands of minutes of calling with respect to price per minute, from Sweden to Germany, the United Kingdom and the United States were estimated to be -0.07, -1.38 and -2.05, respectively. The t-ratio on the price coefficient was 7.3 for the Germany model, 8.2 for the UK model and 6.7 for the US model.

However, recursive estimation indicated that the assumption of constancy is rejected at the 5 per cent level for each of the three country models. Therefore, Hackl and Westlund (1996) estimated time-varying price elasticities using two different approaches. The moving local regression approach indicated that, over the period 1976 to 1990, the absolute price elasticity of demand for telephone calls from Sweden to Germany and the United Kingdom increased, and the range of price elasticities estimated for the United Kingdom was higher than those for Germany. For the United States, in contrast to the results obtained for the other two countries, the absolute price elasticity gradually decreased over the period 1976 to 1990. Somewhat different results were obtained from the Kalman filtering approach, particularly for the United States. The estimates suggested that the price elasticity of demand for telephone calls from Sweden to all three countries increased in absolute terms over the period 1976 to 1990.

Acton and Vogelsang (1992)

Acton and Vogelsang (1992) examined annual telephone traffic between the Unites States and 17 West European countries over the period 1979 to 1986. They estimated the elasticity of demand for international call minutes originating in the United States to be -0.36 with respect to the telephone price per minute from the United States and the elasticity of demand for international call minutes terminating in the United States to be -0.49 with respect to the telephone price per minute to the United States. Both elasticity estimates were found to be statistically significant. Cross-price demand elasticities were generally not significant.

Acton and Vogelsang (1992) also included a range of economic and demographic variables in their model. Their results indicated that the level of GDP in both the United States and European countries had a positive effect on volume of calling in both directions. The number of telephones was found to be very significant and provided a more than proportional increase in volume of minutes. International calling was also found to increase with greater than average employment in the following sectors: agriculture, restaurants and hotels, banking and financial and manufacturing.

Bewley and Fiebig (1988)

Bewley and Fiebig (1988) estimated demand elasticities for three international telephone services in Australia: station-to-station services, person-to-person services and direct dialling services — International Subscriber Dialling (ISD). They also made a distinction between the initial decision to make a telephone call and the decision concerning the length of the call. The analysis used quarterly data from 1976 to 1983 resulting in only 27 observations. During the period of analysis, direct dialling services were rapidly diffused and by the end of the sample period accounted for over 60 per cent of total traffic. Bewley and Fiebig (1988) estimated a range of elasticities of demand for different services with respect to different prices for both the long run and short run over both long-haul and short-haul distances. Some of these price elasticities are presented in Table A.3.

With respect to the ISD tariff, the own-price effect was found to be inelastic in the short run but quite elastic in the long run. There was a strong substitution effect found between ISD and station calls from changes in the ISD tariff. Also, for changes in the operator connected tariff, there was a substitution effect into ISD calls but this was not as strong. Somewhat suprisingly, person calls were found to behave as complements for ISD calls — they responded directly rather than inversely to changes in both prices (Bewley and Fiebig 1988). For increases in the surcharge the main response was a movement from person to ISD calls. However, all effects were relatively small.

Table A.3: **Price elasticities of demand for different services with respect to per minute tariffs**

	Short run			Long run		
Price	ISD	Person	Station	ISD	Person	Station
			Long-haul			
ISD tariff	-0.30	-0.35	0.61	-1.62	-1.92	3.32
Operator connected tariff	0.15	0.48	-0.55	0.84	2.59	-3.00
Surcharge on person calls	0.14	-0.12	-0.06	0.78	–	-0.32
			Short-haul			
ISD tariff	-0.57	-0.66	0.88	-1.94	-2.24	3.00
Operator connected tariff	0.32	0.86	-0.79	1.10	2.92	-2.69
Surcharge on person calls	0.25	-0.20	-0.09	0.84	-0.68	-0.31

Source: Bewley and Fiebig (1988)

Bewley and Fiebig (1988) also calculated the price elasticities of demand separately for calls and minutes. In the long run over long-haul distances, the price elasticity for calls was estimated to be -0.37 (with a t-ratio of 3.5) and for minutes to be -1.54 (with a t-ratio of 9.1), both with respect to price per minute. Bewley and Fiebig (1988) conclude that the main implications of their results were:

- the surcharge has little or no impact on telephone demand;
- generally, the substitution effects between services are strong, both in terms of calls and minutes; and
- total minutes are more responsive than calls.

Appelbe, Snihur, Dineen, Farnes and Giordano (1988)

This Appelbe et al (1988) study was based on the modelling of point-to-point traffic flows between companies and regions. These pairs of one way traffic flows each form a system of simultaneous equations which were pooled together over groupings of companies. Four groupings were used for the Canada-US models representing customer-dialled short and long-haul traffic for both the full-rate and discount-rate periods. The estimated elasticities of demand for number of minutes with respect to price per minute were all inelastic, ranging from -0.43 for full-rate short-haul to -0.53 for discount-rate long-haul. Both results were found to be statistically significant. As with the findings for long-distance calls in Canada (discussed above), Appelbe et al (1988) found that the discount-rate elasticities were more elastic than the full-rate elasticities and, for both rate periods, the elasticities increased with the average length of haul of the traffic modelled.

Bureau of Transport and Communication Economics (1991)

The BTCE (1991) used the OTC calls equation to model the number of inward and outward international telephone calls. The dependent variable in the equation was the log of the number of both-way international calls. The coefficient of the call charge variable was estimated to be -1.01 (with a t-ratio of 3.8) suggesting a one-to-one relationship between percentage changes in real OTC charges and percentage changes in OTC traffic.

A.5 Broadband services

The Australian broadband demand studies undertaken by Madden and Simpson (1996a, 1996b, 1996c, 1996d) used household surveys to overcome data deficiencies. The household surveys employed experimental choice data generation methods to estimate the demand for broadband services for population subgroups.

The choice experiment was structured so that respondents faced a discrete choice of either subscribing or not subscribing to individual services. Services were defined by product characteristics, including price. The levels of the characteristics were systematically varied to create different alternatives. Alternatives were placed in choice sets. Choice sets were structured so as to require the respondent to trade off characteristics when making a choice. When respondents were not interested in the service, no trade-off was made and so no information was conveyed. Respondents not interested in the services were therefore identified and excluded from the experiment after their sociodemographic characteristics were obtained.

The survey was implemented using a cluster probability technique using randomly generated start points from the Telecom White Pages in each State capital city and Canberra. A total of 715 households were interviewed as a result of calling on nearly 5000 households.

APPENDIX B: DATA ON TELECOMMUNICATIONS TRAFFIC, REVENUES AND COSTS FOR 1995-96

B.1 Introduction

Very few data are published about Australian telecommunications traffic flows, revenues and costs. The amount of information made available has been substantially reduced in recent years. To some extent this is understandable in the light of the increase in competition over this period. At the same time, the amount of information produced has increased, partly due to increased regulatory requirements.

The unavailability of published data means that many data are estimates. The estimates in this appendix are from the following main sources.

Prior to the amalgamation of Telecom and OTC, and the commencement of competition with Optus in 1992, both carriers (especially OTC) were relatively more open about revealing financial and traffic details. Extrapolations of data from the pre-competition period form the basis of many estimates.

Both carriers continue to release some information. In particular, Optus is quite open about its revenues, costs and traffic, and also makes estimates of industry magnitudes.

There are now several industry analysts, including BZW Australia and Paul Budde Communication. These provide estimates of some important aggregates.

AUSTEL collects and processes an increasing amount of data, although much of these are supplied to it on a commercial-in-confidence basis.

B.2 Customer access network (CAN)

Number of services

In 1995–96, there were estimated to be an average of 9.215 million services. There were 9.078 million at the end of 1994–95 and 9.352 million at the end of 1995–96 (AUSTEL 1996, p. 6). According to AUSTEL, 70 per cent are residential (6.45 million) and 30 per cent are business (2.76 million).

CAN revenues

In 1995–96, the sum of residential and business access charges and net connection charges is estimated to result in revenue of $1 790 million. This is based on 6.45 million residential services with a service charge of $139.80 per annum and 2.76 million business services at $240 per annum, resulting in revenue of $1 565 million, plus just over $225 million from charges for service connections (see below). BZW Australia (1996, p. 60) estimate 1995–96 CAN revenue at slightly less — $1 703 million.

The estimated revenue from service connections assumes an average price of $214 for new connections where no wiring exists (based on Telstra's charging schedule, assuming a new house, one wiring point, and that no trenches have to be dug) and $76.50 where there is existing wiring (again based on Telstra's charging schedule, and assuming half these customers also require repairs to existing wiring). In 1995–96, there were about 600 000 new service connections (AUSTEL 1996), generating revenue of 600 000 x $214 = $128 million. From ABS Population Mobility and Housing statistics, on average 1.3 million households and businesses move premises each year, generating revenue from service connections of 1.3 million x $76.50 = $99 million dollars.

CAN costs

The annual costs of the CAN (including depreciation, opportunity cost and maintenance) are not published, but are estimated as approximately $2 387 million in 1995–96. This is based on 75 per cent cost recovery — that is, $1 790 million/0.75 = $2 387 million. Telecom claimed in 1991 that it retrieved 60 per cent of CAN costs from CAN revenues; and this was accepted in the AUSTEL (1991) interconnect report. This would imply a substantially higher cost of $2 983 million. However, in personal communication between Robert Albon and AUSTEL this was disputed as being too low, partly on the basis of 1984–85 data presented to the Prices Surveillance Authority (1984) indicating 81 per cent CAN cost recovery. AUSTEL conceded that the cost recovery was 'between 70 and 80 per cent', and 75 per cent is the mid-point of this range. There is no substantial reason to expect that this relativity will have changed since 1991.

The average cost of the CAN per subscriber is around $235. Total cost is $2 387 million, and assuming that connection revenue of $225 million covers its costs, the cost of providing access is $2 162 million ($2 387 million – $225 million) and the average cost is $2 162 million/9.215 million = $235. This is consistent with the statement by the Minister for Transport and Communications (1988, p. 87) that 'non-business rental does not necessarily meet the full cost of providing the service ... even in metropolitan areas, and is cross-subsidised to some extent', but 'business rentals probably cover costs for business users on average ...' $235 is taken as an estimate of long-run marginal cost of sustaining the CAN.

CAN deficit

These revenue and cost estimates suggest an overall CAN deficit of $597 million ($2 387 million – $1 790 million).

B.3 Local exchange network (LEN)

Local exchange network traffic

The number of local calls was published until 1991–92, when there were around 9.4 billion. In 1995, it was reported that the market for local calls yields 'revenue of $2.6 billion in 1993–94 on 10 billion calls made [with growth] ... steady at 6 per cent.' (Helen Meredith, 'Ringing in a phoney war', *Australian Financial Review*, 30 January 1995). This suggests around 11.2 billion calls in 1995–96. In terms of minutes, these local calls have been estimated to average 4 minutes (Stewart Fist, 'Telstra's timely treachery', *Australian*, 16 April 1996), yielding about 44.8 billion local call minutes.

The local exchange network also reticulates higher level traffic — domestic long-distance, international and mobile-to-fixed wire calls. Domestic long-distance calls, international calls and mobile calls could account for around 6 billion uses. The number of these calls has not been published since 1991–92 when there were 1 938 million, 120 million and 319 million, respectively, or 4 315 million local uses. All of these will have grown substantially, especially international calls and mobile calls. The 6 billion number is a (conservative) guess. Higher level calls (other than mobiles) account for about 24.2 billion minutes (11 200 million x 2 + 1 800 million) of LEN use (see below).

Local call revenues

Local calls are charged at a flat rate of 25 cents each, unless subject to a flexi-plan where the price can be as low as 21 cents. BZW Australia (1996, p. 60) estimates local call revenue in 1995–96 to be $2 513 million, but this appears to be a slight underestimate. In 1995, the CEO of Telstra, Frank Blount ('Blount's Gambit', *Australian*, 21 July 1995) implied that the revenue from local calls was around $3 billion. Blount said that a reduction in the price from 25 cents to 15 cents would mean a loss of (revenue?) of $1.2 billion, implying initial revenue of at least $3 billion. A senior industry unionist (Colin Cooper, Letter to Editor, *Australian Financial Review*, 27 July 1995) estimated it would 'wipe nearly $1 billion off Telstra's balance sheet', implying a starting revenue of about $2.5 billion, but only if it were assumed that the reduction in price resulted in no increase in net revenue. Local call revenue in 1995–96 is estimated at $2.6 billion or 23.2 cents per call ($2.6 billion/11.2 billion).

Local exchange network costs

The total cost of the local exchange network is estimated to be in the region of $1 700 million. This is based on earlier observations of the extent of cost recovery from local call revenue. 1984–85 data presented by Telecom to the Prices Surveillance Authority (1984) showed that expenses for local calls (including depreciation) were 69 per cent of local call revenue. Ergas, Ralph and Sivakumar (1990, Table 15) show costs of 71 per cent of local call revenue for 1987–88. Since then, local call prices have risen from 20 cents to 25 cents, a slight fall in real terms, but volumes have grown sufficiently to counteract that effect, roughly preserving local call revenues in real terms (that is, rising roughly with the CPI). Improvements in switching and inter-exchange transmission technology may have reduced costs slightly in real terms, suggesting a slightly lower relativity, perhaps around 65 per cent.

Marginal cost of using the LEN

The marginal cost is difficult to estimate, partly because it depends on the extent to which demand is near capacity. Non-congested short-run marginal cost is low as the bulk of the costs of the local network are not variable with usage. There has been some controversy about the extent of congestion, with Telstra recently suggesting that Internet use is congesting the local network. However, Stewart Fist ('It would pay Telstra to roll out ISDN — now', *Australian*, 12 November 1996) argues that congestion of the local network has been decreasing recently, and this is verified by AUSTEL data. In view of fixed costs and improving technology, long-run marginal cost of expanding capacity is likely to be less than average total cost. From another perspective, total cost can be construed as the cost of keeping the local network 'alive' in the long run — depreciation and opportunity cost of capital, plus maintenance. Average total cost is about 9.88 cents per call/reticulation ($1 700 million/17 200 million), and this is an upper bound of 'long-run marginal cost'.

On a per minute basis, the average total cost (an upper bound of 'long-run marginal cost') is about 2.5 cents ($1 700 million/69 billion).

B.4 Long-distance network

Long-distance traffic

Long-distance traffic minutes have to be estimated in conjunction with international traffic.

Optus (1996) estimates the total number of long-distance minutes carried in Australia in 1995–96 (including international outgoing and incoming minutes) at 13 000 million, of which Optus itself carried 2 092 million or 16.1 per cent. In 1995–96 Optus carried approximately 399.7 million international minutes (see international traffic section below). This leaves Optus with 1 692.3 million domestic long-distance minutes in 1995–96.

Telstra/SP domestic long-distance minutes can be calculated by subtracting all international minutes (see international traffic section below) and Optus domestic long-distance minutes from the total number of long-distance minutes. This leaves Telstra/SP with 9 507.7 million domestic long-distance minutes in 1995–96 (13 000 million – 1 800 million – 1 692.3 million).

Long-distance revenues

BZW Australia (1996, p.60) estimates Telstra's STD revenue (net of resellers) at $2 476 million. SPs were estimated to pay $537 million to Telstra for basic carriage services (long-distance and international). The international component of this is estimated at $128.6 million (based on $150 million retail sales which roughly reflects the service providers' share of the estimated international market — see below), leaving $408.4 million for STD re-sale. As SPs are reported to pay 85 per cent of the retail price, their payment represents $480.4 million in domestic long-distance retail sales ($408.4 million/0.85). This gives a total Telstra/SP retail revenue of $2 956.4 million. Optus has 15.1 per cent of minutes but charges a little (say 5 per cent) less for calls, leaving it 14.35 per cent of total STD revenue. This implies a total long-distance revenue of $3 452 million ($2 956.4 million/0.8565) and that Optus has $495.5 million (0.1435 x $3 452 million).

Total long-distance revenue: $3 452 million

Telstra/SP long-distance revenue: $2 956 million
(31.1 cents per minute based on 9 507.7 million minutes)

Optus long-distance revenue: $495.5 million
(29.3 cents per minute based on 1 692.3 million minutes)

Long-distance costs

The total cost of the long-distance network is not available publicly. In the past, where it has been published it has indicated total costs well below revenues. In 1984–85 estimates supplied by Telecom to the PSA (1984), the cost of the long-distance network was $437 million compared with total revenue of $1 469 million. For 1987–88, Ergas, Ralph and Sivakumar (1990, Table 15) report 'avoidable' costs of only $256 million and revenue of $2 269 million. Since then, unit carriage costs have been progressively reduced by the implementation of new transmission media, but the capacity of the network has been increased. It was observed in 1995 that 'margins are well over 500 per cent on much long-distance traffic' (Tom Burton, 'Telecom scents deregulated profit', *Australian Financial Review*, 21 July 1995), implying total costs could be as little as $500 million. These available data suggest that an upper bound estimate of total cost for 1995–96 is $700 million.

Average and marginal cost of long-distance

The average cost per call minute for Telstra is about 7.36 cents ($700 million/9 507.7 million). This is also taken to be the estimate of 'long-run marginal cost'; although it is likely to be an upper bound. Adding in twice the marginal cost per minute for local reticulation (2.5 cents x 2 = 5 cents) gives an aggregate 'long-run marginal cost' per minute of 12.36 cents.

B.5 International

International traffic

Iain Falshaw of Optus (personal communication) estimated that in 1995–96 Australia's international call traffic was comprised of approximately 1000 million outgoing minutes and 800 million incoming minutes. Using these estimates of international minutes and AUSTEL (1996) market shares for 1995–96, the number of minutes Telstra and Optus carried into and out of Australia in 1995–96 can be calculated.

Using AUSTEL (1996) market shares for outgoing international calls for the last three quarters of 1995–96 (market shares for the first quarter are not available) and interpolating the market share for the first quarter to calculate market shares for the whole year indicates that Telstra carried 63.84 per cent or 638.4 million outgoing international minutes and Optus carried 22.89 per cent or 228.9 million outgoing minutes in 1995–96.

AUSTEL (1996) only published market shares for incoming minutes for two quarters in 1995–96. Using these market shares (from October 1995 to March 1996) and interpolating the remaining two quarters to calculate total 1995–96 market shares indicates that Telstra carried 77.2 per cent or 617.6 million incoming minutes and Optus carried 21.35 per cent or 170.8 million incoming minutes in 1995–96.

The remainder of outgoing and incoming international minutes were carried by service providers.

International revenues

The total international outgoing and incoming market is estimated to be $1 628 million ($1 122 million for Telstra + $150 million for SPs + $356 million for Optus).

Telstra's revenue from outgoing and incoming international call markets in 1995–96 has been estimated to be $1 122 million (BZW Australia 1996). Telstra's revenue from incoming international calls is the settlement rate (the amount Telstra receives from and pays to the foreign carrier) for terminating an international call minute multiplied by the number of incoming minutes carried. Personal communication with Iain Falshaw of Optus indicated that the traffic-weighted average settlement rate on outgoing international traffic in 1995–96 was approximately 65 cents per minute. While the weighted average settlement rate on incoming international traffic is not necessarily the same as that on outgoing international traffic, in the absence of relevant information, the settlement rate on incoming international traffic is assumed to be 65 cents per minute.

The weighted average settlement rate for Telstra is assumed to be the same as for Optus. This appears to be a reasonable assumption given that published accounting rates (United States and United Kingdom) show only a slight difference between Telstra and Optus. Using 65 cents as the weighted average settlement rate, Telstra's total revenue from incoming call minutes in 1995–96 was $401.4 million ($0.65 x 617.6 million). Taking incoming revenue from total revenue leaves revenue from outgoing calls of $720.6 million. This gives an average price per minute of $1.129 ($720.6 million / 638.4 million).

Optus's average price per minute of an international call is assumed to be 5 per cent below Telstra's. This gives an Optus average price per minute of $1.072 and a total Optus revenue of $356 million — $245.4 million from outgoing calls ($1.072 x 228.9 million) and $111 million from incoming calls ($0.65 x 170.8 million).

International costs

The cost to Telstra and Optus of carrying an outgoing international call is estimated to be 75.9 cents per minute.

The cost of originating an international call (carrying a call from the caller's handset to the midpoint of the international gateway) is estimated to be 10.9 cents per minute. This estimate assumes that 60 per cent of all outgoing international minutes originate in Sydney or Melbourne. Both Sydney and Melbourne have international gateways, so calls originating in these cities only need to be carried locally to the international gateway. For outgoing minutes carried locally the cost of carriage to the international gateway is estimated to be 2.5 cents per minute (see section on local call costs above). The remaining 40 per cent of international minutes are assumed to be carried long-distance to Sydney or Melbourne and then locally to the international gateway. The average long-distance carriage cost is estimated at 7.36 cents per minute (see section on long-distance call costs above). Therefore, the average long-run marginal cost of carrying a call to the international gateway is (0.6 x 2.5 cents) + (0.4 x (2.5 cents + 7.36 cents)) = 5.4 cents per minute. The cost of utilising the international switch is estimated to be at most 3 cents per minute. The long-run marginal cost of carrying the call from Australia's international gateway to the midpoint of the international circuit is estimated to be 2.5 cents per minute (BTCE 1993). Therefore, the cost of originating an international call is estimated to be 10.9 cents per minute (5.4 cents + 3 cents + 2.5 cents).

As discussed above, the cost of termination is the settlement rate. The average weighted settlement rate for Telstra is assumed to be the same as that for Optus which was reported to be 65 cents per minute in 1995-96. Therefore, the total cost (origination plus termination) to Telstra and Optus of an international call is 75.9 cents per minute (10.9 cents + 65 cents).

APPENDIX C: DETAILS OF ESTIMATING THE EFFICIENCY GAINS FROM PRICE REBALANCING

This appendix provides details of the estimation of the efficiency gains reported in Chapter 8. The appendix presents the data used in the price rebalancing analysis, briefly reviews the problem with the current pricing structure and explains the methodology used for rebalancing prices. Results from a range of pricing scenarios are presented and the sensitivity of these results to variations in the estimates used in the analysis are examined.

C.1 Estimates used in the Telstra price rebalancing analysis

The price rebalancing analysis conducted for this report examined five of Telstra's telecommunications markets: residential customer access, business customer access, local calls, long-distance calls and international calls. The base case for the price rebalancing analysis required information on Telstra's current pricing structure, including traffic, revenue and cost data. To calculate the change in traffic from the base case (and hence the change in revenue, cost and efficiency) resulting from a rebalancing of prices, the price elasticity of demand was also required for each of the five markets examined.

The source and generation of long-run marginal cost (proxied by total cost divided by traffic), price (proxied by total revenue divided by traffic) and traffic data for each of the five telecommunications markets are discussed in Appendix B and are summarised below in Table C.1.

The price elasticities of demand used in the analysis, which are also presented in Table C.1, were drawn from Chapter 3 and Appendix A which reviewed a range of empirical telecommunications demand studies. The relevant elasticities from these studies were used to calculate an average price elasticity of demand for each of the telecommunications markets, with the exception of the international market, where the elasticities were not averaged (see below). The relevant elasticities were those that were estimated for the quantity and price dimensions appearing in Table C.1. For example, the price elasticity of demand for the long-distance calls market used in the price rebalancing analysis was calculated by averaging the surveyed elasticities that were estimated in terms of demand for the number of long-distance call minutes with respect to the price per minute of a long-distance call.

Table C.1: **Estimates used in the Telstra price rebalancing analysis, 1995–96**

Telstra markets	*Price*	*Long-run marginal cost*	*Traffic/ quantity*	*Net Revenue*	*Efficiency loss*[a]	*Price elasticity of demand*
				million	*million*	
Residential customer access	$139.80 per connection	$235 per connection	6.45 million connections	-$614	$8	-0.04
Business customer access	$240 per connection	$235 per connection	2.76 million connections	$14	$0	0.00
Local calls	$0.232 per call	$0.099 per call	11.2 billion calls	$1 492	$26	-0.06
Long-distance calls	$0.311 per minute	$0.124 per minute	9.51 billion minutes	$1 782	$322	-0.60
International calls	$1.129 per minute	$0.759 per minute	638 million minutes	$236	$46	-1.20
Total				$2909	$402	

[a] Efficiency loss relative to long-run marginal cost pricing.
Source Appendix A, Appendix B and Chapter 3.

Most studies of international telephone demand use US data (see Chapter 3 and Appendix A). Unlike in the United States, a large proportion of international calls from Australia (70 per cent, according to AUSTEL 1995e) are made by residential users. As residential demand for international calls is more sensitive to price changes than business demand, US studies are likely to underestimate the price elasticity of demand for international calls from Australia.

Therefore, the elasticity of demand for international calls used in this analysis is drawn from Bewley and Fiebig (1988). Bewley and Fiebig, using Australian data from 1978 to 1983, estimate that the elasticity of demand for an international call minute with respect to the price per minute is -1.2 in the short run and -1.5 in the long run (excluding international calls to New Zealand and Papua New Guinea). Given that international call prices from Australia have fallen substantially since 1983, these elasticity estimates are likely to be too high (see de Fontenay and Lee 1983). Therefore, the lower estimate of -1.2 is used in this analysis.

C.2 The price rebalancing analysis

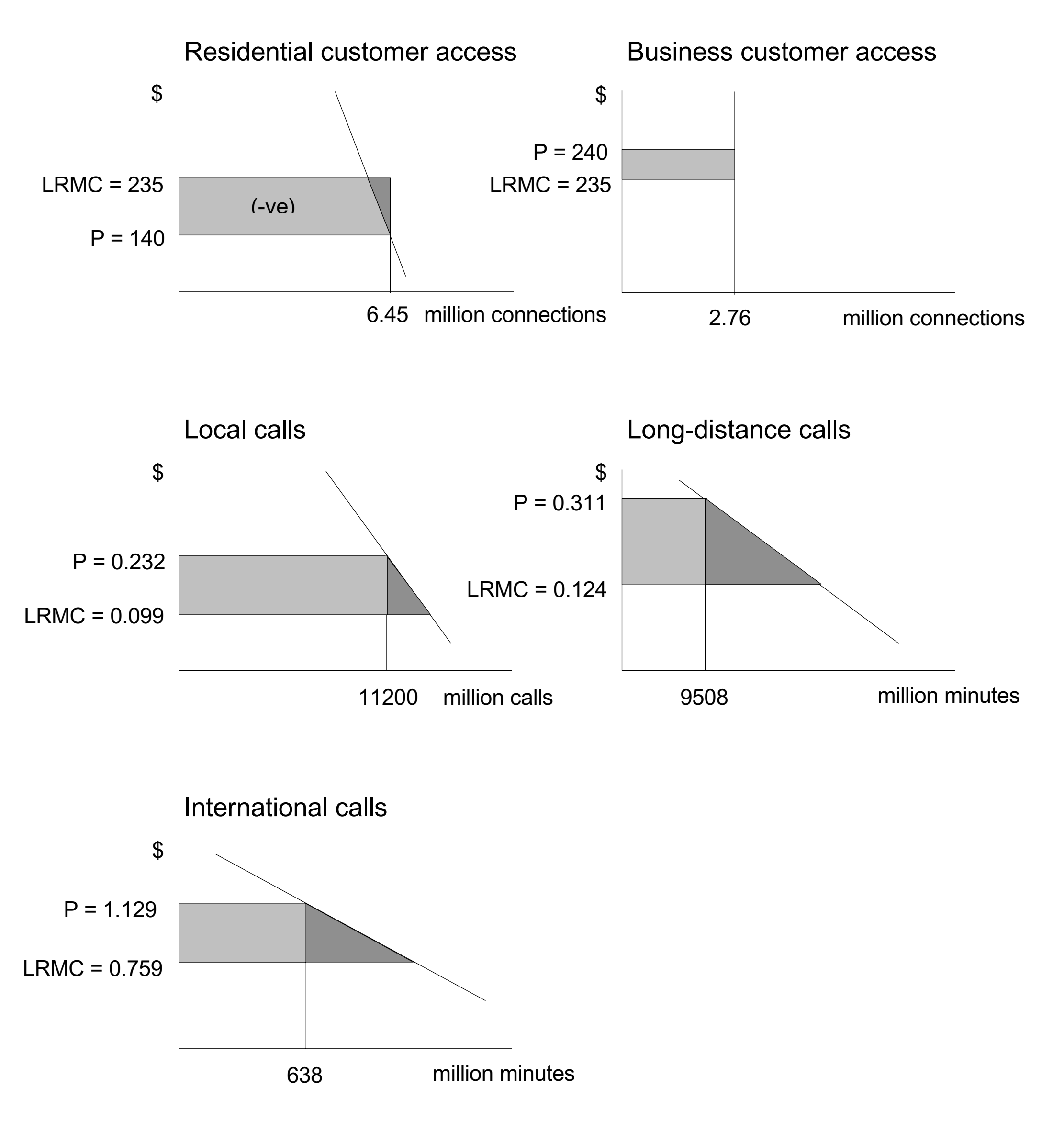
The data presented in Table C.1 reveal that there is a gap between price and long-run marginal cost in each of the five telecommunications markets. As discussed in Chapter 4, economic efficiency will be maximised when price equals marginal cost. Therefore, the gap between Telstra's marginal cost of a telecommunications service and the price it charges consumers reflects a loss in economic efficiency. Using the price, cost, traffic and elasticity estimates in Table C.1, this total efficiency loss over all five markets was estimated to be $402 million in 1995–96.

While marginal cost pricing will eliminate this loss in economic efficiency, it will not meet Telstra's net revenue constraint. As the data presented in Table C.1 indicate, total revenue less total cost for the five Telstra markets was approximately $2.9 billion in 1995–96. The pricing solution that keeps this net revenue constraint intact will obviously involve price being above marginal cost in at least one of the five markets. The objective of the price rebalancing analysis was to find the pricing solution for the five telecommunications markets that would minimise the loss in economic efficiency, or maximise the gain in efficiency over the 1995–96 structure, while meeting the $2.9 billion net revenue constraint. Figure C.1 presents this price rebalancing problem diagrammatically.

In Figure C.1 (not drawn exactly to scale), the estimated efficiency loss of Telstra's current pricing structure is represented by the hatched areas in each of the five markets. These areas correspond to the efficiency loss column in Table C.1. The business customer access market does not have any efficiency loss at any price because the estimated elasticity of demand is zero. For any of the other four markets, any price that is closer to long-run marginal cost than the current price will reduce the size of the hatched area. Therefore, the price rebalancing analysis involves minimising the sum of the hatched areas by varying the prices in each market while also meeting the net revenue constraint.

The net revenue of Telstra's current pricing structure in each market is represented by the shaded areas. These correspond to the net revenue column in Table C.1 (note that the shaded area in the residential customer access market represents a net loss). The constraint on all of the price rebalancing scenarios was that the change in the sum of the shaded areas was equal to zero.

Figure C.1: **Price rebalancing problem**



The above price rebalancing problem was solved algebraically by finding *POi* to minimise:

$$\sum_i \left\{ (POi - LRMCi) \times \begin{bmatrix} (QCi + \; i \times QCi \times (LRMCi - PCi)/\,PCi) - \\ (QCi + \; i \times QCi \times (POi - PCi)/\,PCi) \end{bmatrix} \right\} \times \frac{1}{2}$$

subject to the constraint:

$$\left\{\sum_i \begin{bmatrix} POi \times \left(QCi + \quad i \times QCi \times \left(POi - PCi\right) / \ PCi\right) - \\ LRMCi \times \left(QCi + \quad i \times QCi \times \left(POi - PCi\right) / \ PCi\right) \end{bmatrix} - \begin{bmatrix} \left(PCi \times QCi\right) - \\ \left(LRMCi \times QCi\right) \end{bmatrix}\right\} = 0$$

where:

i	are the telecommunications markets 1 to 5;
PO	is the optimal price solution;
LRMC	is the long-run marginal cost;
QC	is the 1995–96 quantity demanded;
PC	is the 1995–96 price; and
η	is the price elasticity of demand.

The problem was solved using Microsoft Excel 5.0 Solver.

C.3 Results of price rebalancing analysis

The base case used for all pricing scenarios was the estimated 1995–96 Telstra pricing structure, presented in Table C.1. All changes in price, traffic, cost, revenue and efficiency were calculated as changes from this base case.

Table C.2: **Optimal prices, net revenue neutral with no price constraints**

Market	*Constraints*	*Solution price*	*Net revenue contribution*	*Efficiency gain over the base case*
			million	*million*
Residential customer access	none	$235 per year	$0	$8
Business customer access	none	$1 287 per year	$2 909	$0
Local calls	none	$0.099 per call	$0	$26
Long-distance calls	none	$0.124 per minute	$0	$322
International calls	none	$0.759 per minute	$0	$46
Total	revenue neutral		$2 909	$402

The first pricing scenario examined was exactly as described above — all prices were allowed to vary in order to minimise the sum of the efficiency losses while keeping total net revenue unchanged. The resulting prices and efficiency gains are presented in Table C.2. As expected the net revenue constraint of $2.9 billion was met solely by a contribution from the business customer access market, with an estimated zero price elasticity of demand. Prices for the four remaining markets moved to long-run marginal cost. The resulting total efficiency gain over the base case was $402 million.

Since it is not clear that the business access elasticity would remain at zero for such a large price increase, a price of $1 287 per year for business customer access is unlikely to be implemented in practice. Therefore, a second scenario was examined under which the price of business customer access was constrained to a more realistic value ($350) while allowing the four remaining prices to vary to minimise the sum of the efficiency losses. The results of price rebalancing under this scenario are presented in Table C.3. The optimal price of residential customer access was well above marginal cost, while the price of a local call increased slightly (relative to 1995–96 levels) from $0.232 to $0.235. Prices in the two remaining markets fell towards marginal cost. The total efficiency gain over the base case was $356 million.

Table C.3: **Optimal prices, net revenue neutral with business customer access price constrained**

Market	*Constraints*	*Solution price*	*Net revenue contribution*	*Efficiency gain over the base case*
			million	*million*
Residential customer access	none	$354 per year	$723	-$5
Business customer access	price = $350	$350 per year	$318	$0
Local calls	none	$0.235 per call	$1 529	-$1
Long-distance calls	none	$0.148 per minute	$301	$317
International calls	none	$0.804 per minute	$38	$46
Total	revenue neutral		$2 909	$356

As the price of residential customer access is currently set well below marginal cost, while the optimal price in the scenario just examined puts it above the business customer access price, this set of prices would be difficult to implement in practice. Therefore, an additional constraint was introduced under a third scenario — the price of residential customer access was equated to its long-run marginal cost. This price rebalancing scenario resulted in the price for local calls increasing to $0.291 per call and the per minute prices for long-distance and international calls falling, but by less than under the previous scenario. The total efficiency gain over the 1995–96 pricing structure was estimated to be $337 million (see Table C.4).

Table C.4: **Optimal prices, net revenue neutral with business and residential customer access prices constrained**

Market	*Constraints*	*Solution price*	*Net revenue contribution*	*Efficiency gain over the base case*
			million	*million*
Residential customer access	price = $235	$235 per year	$0	$8
Business customer access	price = $350	$350 per year	$318	$0
Local calls	none	$0.291 per call	$2 120	-$28
Long-distance calls	none	$0.158 per minute	$418	$312
International calls	none	$0.822 per minute	$53	$45
Total	revenue neutral		$2 909	$337

However, as discussed in the Chapter 8, the AUSTEL price sub-cap regulation on local calls freezes the standard local call charge to be equal to or below its current level. Also, any pricing solution that increases the price of a local call is likely to be unattractive to Telstra because of competition in the local calls market. Therefore, an additional constraint was introduced to examine the effect of the sub-cap regulation on local calls. The price of a local call was constrained to be at or below its 1995–96 estimated average price of $0.232 per call, while also constraining the price of customer access to $350 per year for businesses and $235 (marginal cost) per year for residences. This scenario resulted in the per minute price of long-distance and international calls falling to $0.209 and $0.919, respectively (see Table C.5). The total efficiency gain over the base case was $301 million.

Table C.5: **Optimal prices, net revenue neutral with business and residential customer access and local call prices constrained**

Market	*Constraints*	*Solution price*	*Net revenue contribution*	*Efficiency gain over the base case*
			million	*million*
Residential customer access	price = $235	$235 per year	$0	$8
Business customer access	price = $350	$350 per year	$318	$0
Local calls	price <=$ 0.232	$0.232 per call	$1 492	$0
Long-distance calls	none	$0.209 per minute	$975	$255
International calls	none	$0.919 per minute	$124	$38
Total	revenue neutral		$2 909	$301

Table C.6: **Optimal prices, net revenue neutral with business and residential customer access and local, long-distance and international call prices constrained**

Market	*Constraints*	*Solution price*	*Net revenue contribution*	*Efficiency gain over the base case*
			million	*million*
Residential customer access	price <= $140	$140 per year	-$614	$0
Business customer access	price = $350	$350 per year	$318	$0
Local calls	price <=$ 0.232	$0.232 per call	$1 492	$0
Long-distance calls	price <= $0.311	$0.272 per minute	$1 520	$119
International calls	price <= $1.129	$1.036 per minute	$194	$21
Total	revenue neutral		$2 909	$140

In addition to the local call sub-cap regulation, the AUSTEL price sub-cap regulations also constrain the price of residential access rentals, long-distance and international calls. Therefore, a fifth scenario was examined which also constrained the solution price of residential access, long-distance and international calls to be equal to or below their 1995–96 levels. This resulted in the residential customer access price being set to its current level of $140 per year and the price per minute of long-distance calls and international calls falling to $0.272 and $1.036, respectively (Table C.6). The efficiency gain from this scenario over the 1995–96 pricing structure was estimated to be $140 million.

C.4 Incorporating effects of changes in Optus's prices

The methodology used for calculating the additional efficiency gains resulting from Optus following Telstra's price rebalancing is described in Chapter 8. The starting values used for calculating the change in Optus's prices, traffic and efficiency are presented in Table C.7. The source and generation of these data are discussed in Appendix B.

Table C.7: **Estimates used to calculate the effects of changes in Optus's prices, 1995–96**

Optus markets	*Price*	*Long-run marginal cost*	*Traffic*	*Net Revenue*	*Efficiency loss*[a]	*Price elasticity of demand*
	per minute	*per minute*	*minutes*	*million*	*million*	
Long-distance calls	$0.293	$0.124	1.69 billion	$286	$50	-0.60
International calls	$1.072	$0.759	229 million	$72	$13	-1.20
Total				$358	$62	

[a] Efficiency loss relative to long-run marginal cost pricing.
Source: Appendix A, Appendix B and Chapter 3.

C.5 Sensitivity of results to assumed elasticities of demand

The efficiency gains resulting from the price rebalancing analysis are most sensitive to the elasticity of demand estimates used in the long-distance call market. Under each of the scenarios examined above, most (between 80 per cent and 92 per cent) of the efficiency gains that were achieved as a result of moving from the 1995–96 pricing structure to the price rebalancing solution were contributed by price changes in the long-distance call market. This is because the long-distance call market accounted for the majority of efficiency losses in the 1995–96 pricing structure, because of the relatively large gap between price and marginal cost and its fairly elastic demand compared with the access and local call markets. Therefore, even a small fall in the price of a long-distance call minute toward marginal cost results in a large (although less than proportionate) increase in the demand for long-distance call minutes and hence a large increase in economic efficiency.

The most questionable estimate used to calculate efficiency gains in the long-distance call market is the price elasticity of demand for long-distance call minutes. There were no statistically significant Australian estimates of the price elasticity of demand for long-distance call minutes with respect to price per minute. Therefore, the elasticity used in the price rebalancing analysis was an average of the elasticity estimates from overseas studies. This assumed that overseas elasticity estimates applied to movements around similar starting points as in Australia. This was considered to be a reasonable assumption given that the elasticity estimates were drawn from studies based on pricing structures similar to those in Australia.

However, the possibility of different reactions of quantity to price changes was considered by examining how sensitive the efficiency results of the price rebalancing analysis are to the estimated price elasticity of demand. The five price rebalancing scenarios examined above were repeated using alternative values of the price elasticity of demand for long-distance call minutes. Table C.8 reports the efficiency results of the five price rebalancing scenarios when the base case price elasticity of demand for long-distance call minutes (-0.60) was varied by plus and minus 25 per cent and plus and minus 50 per cent. These alternative elasticity estimates also provide an indication of how the price rebalancing results would have varied had the exact values from the demand studies surveyed in Chapter 3 and Appendix A been used instead of their average. The base case elasticity of -0.6 was calculated by averaging two price elasticities of demand for long-distance call minutes with respect to price per minute, -0.72 and -0.48. These elasticity estimates are close to the plus and minus 25 per cent cases presented in Table C.8.

The sensitivity analysis indicates that the efficiency estimates are sensitive to the price elasticity of demand for long-distance call minutes. Under scenario 5, for example, the efficiency gains are 55 per cent of those in the base case when -0.30 is used as the elasticity of demand for long-distance call minutes, and 167 per cent of those in the base case when -0.90 is used as the elasticity of demand.

The sensitivity analysis also reveals that, even if the demand for long-distance call minutes was relatively inelastic, the efficiency gains from rebalancing telecommunications prices would still be substantial. Similarly, the more elastic the demand for long-distance call minutes with respect to the price per minute, the greater the efficiency gains from price rebalancing.

Table C.8: Sensitivity of efficiency results to variations in the price elasticity of demand for long-distance call minutes

Scenario	*Total efficiency gain[a], $ million*				
	minus 50% *-0.30*	*minus 25%* *-0.45*	*base case* *-0.60*	*plus 25%* *-0.75*	*plus 50%* *-0.90*
Scenario 1	241	322	402	483	563
Scenario 2	198	277	356	436	517
Scenario 3	181	258	337	416	496
Scenario 4	168	232	301	372	446
Scenario 5	77	104	140	183	234

a Efficiency gain over the 1995–96 pricing structure (see Table C.1).

It is also important to note that the efficiency gains in the above price rebalancing analysis were calculated by assuming that the *slope* of the inverse demand curve, derived from the estimated price elasticity of demand, remained constant for movements from the starting price. Some support for this assumption is given in de Fontenay and Lee (1983). The alternative assumption is that the price elasticity of demand remained constant, in which case the slope of the inverse demand curve would have become flatter as the price was reduced. By assuming that the slope, rather than the elasticity, remains constant, the estimated efficiency gains from price rebalancing presented in this appendix are conservative. In addition, the analysis ignores the cross-price elasticity of demand for access, whereby reductions in call prices could increase the demand for access and lead to further gains in efficiency.

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