Chapter 15

LOCAL NETWORK COMPETITION

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Contents

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I. INTRODUCTION

1.1. Scope and Objectives of this Chapter

This chapter surveys the economic analysis of competition in markets for local telecommunications services.[1] Its main objective is to understand patterns of competition in these markets and evaluate its benefits and costs against the alternative forms of industrial organisation. While regulation is not a principal focus, policies governing rates and investment of providers–incumbents and entrants alike–can greatly affect the extent of competition. More recently, the opening of incumbent networks and the unbundling of network services for sale to competitors has become the preferred means to move toward competition in these markets. Technology has the potential to make all this policy irrelevant by sweeping in a new generation of competitors offering innovative services and driving out incumbent providers. Good examples of such a potential is how fixed and mobile wireless technologies could replace traditional wireline services, and how packetised voice and data can run on many alternative media, not just the traditional public switch telephone network (PSTN). At the same time, new technologies could have the effect of solidifying the dominance of incumbent providers.

The term 'local' in the chapter title deserves some explanation. As usual, it has a spatial meaning, but that is being redefined all the time by changes in technology and public policy. During the very earliest days of the industry, the geographic market ended at the city limits lacking the transmission technologies to overcome the attenuation problems experienced by long distance transmission. Today, as always, much of demand for communication reflects the local nature of social relationships, and so this chapter will include the provision of switched voice services within an urban area. The meaning of local becomes more challenging to define, however, when facilities that provide these services also connect users with individuals and machines located far away. The recent debates over the meaning of local when facilities carry Internet traffic illustrates the difficulty of arriving at a sharp delineation of these markets.

While much demand for communication may still be spatially local, the scope of supply may be far less limited. It may be efficient for a single provider to serve many local areas. Furthermore, it may be technically efficient and strategically advisable for a local service provider to offer customers "non-local" services as well, such as long distance and Internet access. What distinguishes suppliers to these markets is that they provide originating and terminating legs of a communication link, whether that is voice or data, or whether it is over wireline or wireless facilities.

In the past, telecommunications has been synonymous with voice communications. Increasingly that term has come to include one-way image and video transmissions and interactive data services. We will use the broader interpretation here in the context of local markets. Many services often associated with the telecommunications sector will be excluded however, including video and audio broadcasting (whether over the air or on cable), Internet access, services and content (though we would include dialup access over local loop), and long distance and international service (except to the extent local networks provide

[1] Other recent surveys of local telephone competition include Baumol and Sidak (1994), Vogelsang and Mitchell (1997), Vogelsang and Woroch (1998) and Laffont and Tirole (2000).

origination and termination for these services). We will also exclude the creation and modification of content, the manufacturing of communications equipment and the development of network software.

The reader will soon see that many of the examples found in this chapter are drawn from experiences in the United States, both current and historical. This is limiting to the extent that different paths were followed with different results outside the U.S. At the moment, the range of experiences is particularly broad, as countries experiment with a wide array of approaches to local competition, invariably from the starting point of a state owned monopoly. I will allude to a few of these experiments, keeping in mind that they began well after the opening of markets to competition in the U.S. and so have not had the opportunity to play out.

1.2. Patterns and Themes

The study of local network competition–especially under the world's new institutional and regulatory structures—remains in its infancy. In so many cases it is too soon to register the full impact of new policies toward these industries. And as usual, theory is way ahead of empirical testing. Nevertheless, there are a few distinct patterns that emerge from the record, drawing as well on early history of the industry and the experiences outside the U.S.

To begin with, no inexorable, inherent tendency toward monopoly or toward competition can be discerned from the history of this industry. The past century witnessed several major transformations, first from unregulated monopoly to fierce competition, and then to regulated monopoly, and most recently to (de)regulated competition. Regulation and technological change played key roles in each case–in addition to luck and serendipity. The first episode of competition began when the end of the Bell patent monopoly threw open the doors to local markets around the world. The duplication and waste attributed to this period fed public opinion that competition does not work in this industry, and eventually led to creation of a monopoly franchise reined in by an elaborate regulatory institution in the U.S. and state ownership elsewhere.

Nowadays the view is that regulation does not work and competition is the solution (and to a lesser extent that technology has advanced to the point where competition is viable). Deep dissatisfaction with administrative regulation and a faith in the discipline of competition, along with help from an endless stream of technological innovations, resulted in rebuilding the regulatory infrastructure, to aid competitors of all kinds and to free up incumbents. Ironically, over the near term, government intervention has expanded to guide this transition to competition.

For much of its history, the local telephone industry was thought to be naturally prone to monopoly as a consequence of massive scale and scope economies in provision of services over wireline networks. These economies are still present today but now there are other technologies that have cost characteristics that may support competition. What remains unchanged, however, is the fact that incumbent suppliers enjoy strategic advantages that tend to fortify any initial advantage they may acquire. Sunk facilities have always been a means to gain a first mover advantage, but now it is recognised that such advantages stem from several other sources. In particular, 'network effects' of certain services and user switching costs have the effect of creating a competing network difficult or impossible. New technologies

(such as instant messaging) may be no less susceptible to dominance than more traditional physical networks. These technologies may be capable of supporting more firms but first mover advantages may make it exceedingly difficult for them to amass a customer base necessary to cover their entry costs.

Dramatic shifts over time in the consensus regarding the relative merits of competition and monopoly in the local network shake one's confidence in the wisdom of the prevailing view. Only with great humility can anyone claim that competition is desirable and sustainable given the likelihood of technological change and the remaining opportunities for institutional innovation.

2. LOCAL NETWORK COMPETITION IN HISTORICAL PERSPECTIVE

2.1. Local Competition in One City, a Century Apart

As 1894 began, residents of New York City were served by either of two telephone companies: Metropolitan Telephone & Telegraph Co. and New York & New Jersey Telephone Co.[2] For several years, each company had operated under a license to use Alexander Graham Bell's basic telephone patents. But now those patents had expired and, free to exploit these technologies, several companies entered this highly lucrative market with its large population and rapidly growing business community. Adding to the attraction, New York telephone customers were widely dissatisfied with Bell rates and service.[3] Indeed, the average annual charge for local service in the city was $253 in 1915 compared to a nation-wide Bell-company average of $30.93.[4]

At the end of the Bell monopoly in 1894, Mercantile Electric Co. made plans to build an exchange for bankers and brokers, and New York & Eastern Telephone Co. applied to provide service in Brooklyn and Manhattan.[5] Over the next several years, People's Telephone Co., Atlantic Telephone Co., and New York Electric Lines would each make separate bids for some part of the New York City phone market.[6] Each of these entrants would meet with opposition from state and local regulators and from the Bell interests. An 1885 New York state law required all phone lines to be buried underground in the city streets.[7] A monopoly over the underground structures was awarded to the Empire City Subway Co., Ltd. as compensation for undertaking this risky investment.[8] Importantly, a major owner of Empire City Subway was the Bell System itself. As a consequence, entrants into this market were forced to secure essential rights of way from a direct competitor, and it was no surprise when they were told there was no free space and/or charged high access fees while the Bell companies did not directly pay anything for the same rights. Municipal authorities demanded sizeable franchise fees and required competitors to achieve interconnection with an overwhelming percentage of the long distance providers in a short

[2] Wilcox (1910, p. 258).
[3] Gabel (1994, p. 561).
[4] U.S House of Representatives (1915, p. 24). Note that the next three largest cities at that time, Chicago, Philadelphia and St. Louis had average annual rates of $84, $90 and $78, respectively.
[5] Mueller (1997, p. 55).
[6] See Gabel (1994) and Wilcox (1910).
[7] Merchants Association of New York (1905, p.15).
[8] Wilcox (1910, p. 260).

period of time. Unconvinced of the benefits of local telephone competition, New York City municipal authorities would repeatedly deny requests to enter this market.[9]

In the end no independent telephone company would break into the New York City market. On the contrary, the many different operating companies in the city and upstate consolidated into a single operating company, New York Telephone (NYT). Competition nevertheless left its mark, with average monthly charges falling by more than a half before it was over.[10]

Some ninety years later, phone competition would again break out in New York City, but this time it would be more methodical and less visible. In 1982, Merrill Lynch and Western Union formed a joint venture to build a 'satellite park' on Staten Island, one of the five boroughs of New York. This investment was a response to the capacity crunch in the region exacerbated by the explosive growth in the financial services industry, and the companies' desire to have access to a highly reliable network. In a couple of years the project, now privately owned under the name "Teleport," constructed an optical fibre link to Manhattan where it could gather traffic to put out over the satellite network. Eventually, the fibre network would extend throughout lower Manhattan reaching some of the world's most communications-intensive customers. The fibre would be strung under the streets of New York using space owned by none other than the Empire City Subway Co., the same company that obstructed competitors at the end of the previous century.

Fibre optic transmission was a new communications technology but one that had been introduced to the New York market earlier. In 1979, New York Telephone deployed fibre in its interoffice network in Brooklyn.[11] A further difference was that Teleport was laying fibre right to customer's buildings. Also, it built a network that had an extraordinary high level of reliability greatly desired by the financial community and others in the New York area.

In 1986 New Jersey Bell—no longer a part of AT&T—agreed to provide collocation to Teleport's network in or near Bell's central offices in the Newark and Jersey City region. This arrangement allowed Teleport to tap into traffic gathered by New Jersey Bell's network without building out facilities to all the customers. When Teleport sought access to New York Telephone's central offices in New York City, it received a very different reception. NYT claimed that free space in its central offices was scarce and insisted on charging Teleport its retail tariff rates for originating and terminating traffic. After much negotiation, the New York Public Service Commission (NYPSC) ordered NYT to provide Teleport and other alternative access providers with "comparably efficient interconnection" for intrastate private line and dedicated access services.[12] It also required NYT to unbundle its "links and ports" at its switches to enable companies like Teleport to offer its customers local services directly comparable to what NYT offered.

Teleport went on to build fibre ring networks in over 50 cities in North America, Europe and Asia. Ironically, Teleport was purchased in 1998 by AT&T for $11.3 billion and now represents the core of its local business services division.

The two competitive episodes that occurred in New York City are interesting to compare. In both cases a dominant incumbent was exposed to facilities-based competition

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[9] The Brooklyn city council franchised an independent three times during this period only to be vetoed by the city manager on each occasion. Mueller (1997, p. 62)

[10] Mueller (1997, p. 66).

[11] Mikolas (1990).

[12] Much earlier in 1985, the New York PSC authorised Teleport to compete with NYT in New York.

from *de novo* entrants. Success of new entrants turned on their access to rights of way—especially underground conduit—and to collocation and interconnection with the incumbent network. The earlier competitors failed to achieve viability as facilities-based carriers whereas the more recent competitive carriers made huge incursions into Bell market share, especially among large corporate accounts.[13] In the earlier era, business customers rallied against competition, demanding a single franchise provider to avoid the expense of a dual system.

Big changes had taken place over the course of a hundred years, however. In the nineteenth century incumbents and entrants competed for switched local service (though long distance interconnection played a role). In the twentieth century version, they vied instead for long distance access and private lines. Most importantly, earlier competition failed to take hold while by all accounts competition in both residential and business services markets in today's New York City is vibrant and unlikely to return to monopoly any time in the foreseeable future.[14]

Some may argue that the New York City experience does not transfer over to other markets. Indeed, no-where in the U.S. is population density and volume of telecommunications traffic greater than in New York City. Nevertheless events that played out in New York were repeated in large urban areas across the country in the late 1980s and throughout the 1990s–including many of the same regulatory struggles for entry into those markets.

2.2. U.S. Experience with Local Competition and Monopoly

2.2.1. The Bell Patent Monopoly: 1876-1894

As is so well known, in 1876 a teacher of the deaf, Alexander Graham Bell, filed for patents on the telephone transmitter that he called "An Improvement for Telegraphy." Also well known is the fact that only hours later Elisha Gray filed a "caveat" with his intent to file an application with the Patent Office for an invention that also transmitted sound over wires. Western Union, the telegraph behemoth, acquired Gray's device a year later and hired Thomas Edison to perfect the talking telephone. Western Union, the target of a patent infringement suit by the Bell interests, would agree in 1878 to withdraw from the local phone business in exchange for a 20 percent royalty on revenue received by Bell's National Bell Co. through to the expiration of its basic patents.

Bell licensed operating companies to use his telephone technology in mutually exclusive geographic regions. This allowed Bell to deploy the technology quickly without the huge financial burden of building out the networks. In exchange, Bell would receive license fees for the patented telephone technologies usually calculated on the number of instruments rented to customers. In time, the company would begin to take an equity stake in

[13] For instance, Deutsche Bank Alex. Brown (2001) estimate that competitors supply roughly half of all private lines in New York City.

[14] In approving Bell Atlantic's petition application enter the long distance market in New York State, the FCC not only confirmed that the company had met the 14-point checklist for opening its local markets to competition, but concluded that the openness was irreversible. See Federal Communications Commission (1999, pp. 429-443).

the operating companies, giving it control over the pricing, investment and other strategic decisions, including interconnection with other local telephone companies.[15]

During the patent monopoly period, Bell concentrated efforts on selected markets. Licensees initially built systems in large cities in New England and along the Atlantic coast. When the period came to a close, Bell networks were concentrated in the largest population centres[16] and focused on business customers.[17] Bell devoted relatively little effort during these years to developing the local telephone service except to steadily increase its equity stake in its operating companies. Instead it continued to build up its patent arsenal (it was granted an additional 900 improvement patents) and aggressively defended its intellectual property (filing over 600 patent infringement suits during 1877-1893).[18] It also invested in long distance infrastructure correctly foreseeing that intercity service would be an extremely valuable complement to local service.

2.2.2. Early Competitive Era: 1894-1907

Patents over the two basic telephone instruments–the transmitter and the receiver–expired in 1893 and 1894, respectively, ushering in a competitive landrush as any operator could then freely use Bell's technology. By 1894, there were several dozen independent telephone companies, all of which were providing local service. Less than ten years later, no fewer than 1,074 commercial, independent phone companies were operating in the U.S.[19]

Although independents appeared in the smaller cities and rural areas that did not interest Bell, they also directly attacked Bell's urban turf as the New York City story illustrates. A product of this head-to-head competition was the creation of "dual systems" in which two (or more) facilities-based local telephone companies served the same areas of the same cities. The incidence of dual systems was remarkably high. By 1902, less than 10 years after competition was unleashed, of the 1,051 cities with population of 4,000 or more, 1,002 had telephone service, and 451 of these (or 45.1 percent) had two or more local providers.[20] By 1907, 59 percent of cities and towns with population exceeding 5,000 had dual exchanges.[21] It is estimated that 8-13 percent of subscribers in dual system cities took service from more than one phone company.[22]

Dual systems necessarily resulted in duplicate investment, not only in network facilities but also with the multiple handsets, phone numbers and directories that were maintained by homes and businesses. Businesses were especially adverse to the dual system because they saw it as a competitive necessity to subscribe to all local networks. They were not persuaded that the lower prices that derived from competition compensated them for their added costs.

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[15] Brock (1994, p. 63)

[16] By 1894, only 52 towns had phone service of the more than 7,000 towns with a population exceeding 10,000. Also, 346 of largest cities having 27 *percent* of the population had 83 *percent* of the phones. Mueller (1997 pp. 40-41).

[17] As of 1894 90 *percent* of the 240,000 lines were rented to businesses whereas the penetration rate among U.S. households was 1 in 225 (Mueller, 1997, p. 40).

[18] Barnett and Carroll (1993, p. 101).

[19] Bornholz and Evans (1983, pp. 11-12). Several thousand more independents were formed, and went out of business, if municipal and rural systems are included.

[20] Gabel (1969, p. 345).

[21] Mueller (1997, p. 111). Just a half dozen years later that figure would drop to 33 *percent*.

[22] Bornholz and Evans (1983, p. 18).

AT&T responded aggressively to the independents. In addition to defending its patents, the company refused to supply independents with switching and transmission equipment from its manufacturing arm, Western Electric. In each market where AT&T met with competition from independents, the company slashed prices and refused to interconnect with independent's network.

The intense competition for local service had a dramatic impact on the industry. Average amounts paid for phone line rental fell (nominally) from $5.74 per month in 1893 to $1.45 in 1898, a fall of 75 percent.[23] Unquestionably, diffusion of telephone service in the U.S. was accelerated by the price cuts. A total of 258,455 lines in 1893 more than doubled to 562,423 lines five years later.[24] Over this same period, the number of phone per 100 population would more than double from 3.9 to 9.2. Not surprisingly the competition took its toll on profits of AT&T and the independents alike. Whereas AT&T enjoyed a 46 percent profit rate during the patent monopoly period, its rate fell to 8 percent in the competitive period.[25]

While ownership of independent telephone companies was unconcentrated, their overall strategies were co-ordinated to some extent through trade associations. Like AT&T, independents refused to interconnect their local networks. The independents also formed a long distance network to serve their local networks, but symmetrically with Bell, they resisted connecting with AT&T's Long Lines Division.

2.2.3. Regulated Monopoly: 1907-1956

1907 was a watershed year for the early telephone industry. In that year independent telephone companies reached their peak by securing 51 percent of all phones, or 3.1 million out of a total of 6.1 million.[26] In that same year the first state public utility commissions with powers to regulate local telephone service were formed in Wisconsin and New York. And no less significant, Theodore Vail was made chief executive officer of AT&T.

Upon taking charge at AT&T, Vail quickly made major corrections to the company's strategic direction.[27] While he called for an end to the aggressive price wars in markets where the company faced local independents, Vail slashed toll prices by around two-thirds where AT&T competed with independent long distance carriers. He also accelerated the acquisition of independent local companies and equipment manufacturers, and instructed the company's Long Lines Division not to interconnect with independent companies who served the same markets as Bell operating companies (and also some markets where Bell was not present).

Vail, along with many others, had embraced the contemporary notion of 'natural monopoly' and adapted it to the telephone industry. This early version of the concept held that a single firm could best serve the public judged by the quality, reliability and coverage of its service. Vail did not argue that a monopoly delivered service at least cost, but he did

[23] Stehman (1925).

[24] Stehman (1925) op. cit. which also indicates very slow growth during the monopoly period. For instance, between 1888 and 1893, lines per 100 population only grew from 3.2 to 3.9.

[25] Brock (1981, p.117).

[26] Bornholz and Evans (1983, p. 13).

[27] Barnett and Carroll (1993 , p. 112).

claim that competition led to 'unnecessary duplication' characteristic of dual systems.[28] He made clear his willingness to accept reasonable government regulation in exchange for protection from competition, an offer the government eventually accepted.

The country was already on its way to creating the telecom regulatory institutions when, in 1910, the Mann-Elkins Act empowered the Interstate Commerce Commission (ICC) to control AT&T's rates and accounting methods. By 1920, 45 of 48 states had given their public utility commissions the power to regulate local telephone service.[29]

In 1913, responding to an antitrust investigation, AT&T came to agreement with the U.S. Department of Justice. In the 'Kingsbury Commitment,' Bell promised to halt acquisition of competing independents and to interconnect with non-competing independents (provided they satisfied its technical requirements). The company also agreed to divest itself of Western Union Telegraph Co.

It is during this period that the so-called "Bell System" was formed out of 22 wholly owned operating companies, plus Western Electric, Bell Laboratories and the Long Lines Division. Despite the Kingsbury Commitment, AT&T continued to acquire independent phone companies, though this was balanced against shedding of properties outside of large population centres, leaving smaller towns and rural areas to independents. By this time, Apartheid of telephone carriers was complete, with markets divided between Bell and independent companies. Independents' share had fallen to 21 percent with 100 percent connected to AT&T's long distance network by 1934, the year that the landmark Telecommunications Act passed. This Act crystallised the regulatory superstructure that had been taking shape for many years. It created the Federal Communications Commission (FCC) with powers over interstate telecommunications services, a jurisdiction that included local facilities used to provide access to these services. At both the state and federal levels, local service was subject to some form of rate base-rate of return regulation (RB-RORR). This quasi-judicial procedure set rates so as to ensure a 'reasonable' return on invested capital, and controlled which investments were allowed a return.

2.2.4. Early Transition to Competition: 1956-1984

By the end of World War II, the Bell System dominated the local telephone industry in the U.S. with the Bell operating companies (BOCs) accounting for over 90 percent of all local lines at the beginning of this period. This success placed the company in the cross hairs of antitrust authorities, and in 1949 the Department of Justice launched another investigation of AT&T, focusing this time on its ownership of Western Electric. Eventually the two parties would sign a consent decree in 1956 barring the company from providing non-telephone services and building non-telephone equipment, and forcing it to license its patents at reasonable royalties.

Perhaps more significant in its implications for local competition was a Court of Appeals decision in the Hush-a-Phone case that same year.[30] In that decision, following years of FCC flip flopping on the case, the Court overturned two previous FCC rulings that concluded that the Hush-a-Phone device, a metal attachment to the handset that enhanced

[28] AT&T's 1910 annual report.
[29] Stone (1997).
[30] Hush-a-Phone Corp. v. U.S., 238 F.2d 266 (D.C. Circuit, 1956).

privacy of phone conversations in a crowded room, jeopardised the integrity of the public network. Instead the Court decided such devices were legitimate provided they were "privately beneficial without being publicly harmful." Here was the first major crack in the monolithic Bell network.[31]

Another major hole in the monopolistic edifice was created in 1959 when the FCC rendered its 'Above 890' decision.[32] It concluded that there is enough spectrum to allow users to build private microwave networks for voice transmission. Not only did this lay a foundation for competitive long distance companies such as the nascent Microwave Communications, Inc., but also microwave-based bypass providers that appeared on the urban scene in the 1980s. With time, these high frequency bands would be the basis for fixed wireless access methods that are being deployed today.

The next major opening of local markets came in 1968 when the FCC ruled that another device that interconnected the phone network with a private radio system was allowed. In its 'Carterfone' ruling, the FCC articulated some of the first principles of a federal interconnection policy.[33] It expanded allowable competition beyond the Hush-a-Phone decision which involved a network attachment, to include an interconnection device.

A characteristic of this period was judicial leadership in supporting competition into both equipment and long distance service, with widespread reluctance among state and federal regulators. Once again in 1974, the U.S. Department of Justice, goaded by new entrants into telephone markets, launched an antitrust investigation of possible abuse of monopoly power in violation of the Sherman Antitrust Act. Another protracted investigation and trial, this effort would again result in a consent decree between the government and AT&T. This time, the terms would completely transform the local telephone industry.

It would be a mistake to focus entirely on judicial and regulatory explanation for the competition during the post-war period. In fact, technological developments fuelled local competition. Primitive as they may seem by today's standards, the Hush-a-Phone and Carterfone devices were innovations that provided vertical services to the public network; earlier we mentioned microwave transmission as a bypass technology that appeared in this time frame. The microelectronics revolution would enable innovations in switching and transmission technology that again expanded opportunities for competition in local markets. Electronic stored program control switches greatly accelerated connections, and allowed carriers to add new features to basic service by rewriting a software program. These developments also produced the 'private branch exchanges' (PBX). These allowed business customers to displace switching that otherwise would be provided by their local carrier.

Optical fibre technology, first used for communication in the late 1970s, would revolutionise transmission. Initially, optical fibre was deployed in long distance networks to replace microwave transmission. Soon after, local carriers began to replace their interoffice trunks with fibre. And as described earlier, fibre was the killer technology supporting the entry of competitive access providers in high-capacity local access services.

Developments in the wireless technology during this period laid the foundation for what might become the greatest threat to wireline local service. Bell Labs developed the first

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[31] It was not until 1980, that the FCC, as part of its Computer II Inquiry, would move to fully decontrol customer premise equipment. In that decision, the Commission would allow AT&T and GTE to sell equipment through structurally separate subsidiaries.

[32] Allocation of Frequencies in Bands Above 890 Mc, 27 F.C.C. 359 (1959).

[33] Carterfone, 14 F.C.C. 2d 571 (1968).

analogue cellular telephone technology, Advanced Mobile Phone System (AMPS), back in 1947 but did not gain approval to deploy it commercially until 1982.[34] As we will discuss below, when cellular telephone was first rolled out in Baltimore and Chicago in 1983, it did not offer much competition for wireline service. Its price was high, the signal quality and coverage were poor, and the heavy, cumbersome phones were bolted into automobiles. Furthermore, the FCC licensed two carriers for each urban and rural market with one license reserved for the local wireline carrier. The cellular duopoly did not engender much wireless competition, but that changed considerably in 1995 when the FCC licensed up to five additional carriers of Personal Communications Services (PCS) for those very same markets.

2.2.5. Competition by Divestiture and Deregulation: 1984-present

Ending an 8-year investigation and trial, AT&T and the Department of Justice (DOJ) signed a consent decree on January 1, 1982. Called the Modification of Final Judgment (MFJ) because it amended the 1956 consent decree the parties had signed over 25 years earlier, this historic agreement called for a divestiture of AT&T, including the severing of the local operating companies from the rest of the company. The operating companies were grouped into seven regional Bell operating companies (RBOCs) that were geographically quarantined to 162 'local access and transport areas' or LATAs.[35] These were judicial boundaries not necessarily reflecting geography of economic markets.

The RBOCs were allowed, if not encouraged, to enter each other's territories to provide local service. In addition, the MFJ contained no explicit wording that kept AT&T out of these areas, and hence offering its own local service. Other line of business restrictions (LOBs) banned the RBOCs from equipment manufacture and the provision of long distance and enhanced services (except when approved by the Court overseeing the MFJ). Consequently, if they attempted to enter local markets outside their region, they could not bundle equipment and long distance service with local service–a strategy that helped AT&T gain its dominant share in early years of the industry.

An important aspect of the AT&T Divestiture—supplemented by a series of FCC orders—was the nurturing of long distance competition emerging at the time. Indirectly, this long distance competition advanced local competition by exerting pressure on access service markets: thinner margins in long distance drove interexchange carriers and their largest customers to seek cheaper alternatives to RBOCs' access fees.

Competitive access providers, or CAPs, filled this need. Companies like Teleport in New York built high capacity transport networks to interconnect interexchange carriers and to deliver toll access to large business customers. CAPs with their new technology alone could not bring competition to the local exchange, however; regulatory reform was needed to support multiple providers where the incumbents had enjoyed *de facto* franchise monopolies. Local competition initiatives, such as the NYPSC interconnection decision in New York City, exemplified the innovative experiments that were taking place at the state level. Typically, these proceedings were initiated by the entrant phone companies and facilitated by state regulators who eventually mediated an agreement among the companies.

[34] See the chapter by Hausman in this *Handbook* for a description of the history of commercialisation of the AMPS technology in the U.S.

[35] The number of LATAs grew to 193 as non-RBOC areas were added.

Another good example, that again took place in New York State, was the restructuring plan proposed by Rochester Telephone, called "The Open Market Plan."[36] After modification by the NYPSC, Rochester Telephone partitioned itself into a regulated part that sold basic network services to downstream retail carriers, and a competitive part that competed with these carriers free of rate regulation. Several companies began selling local exchange services using the regulated network, including AT&T, Time Warner Cable, Teleport Communications (before its acquisition by AT&T) and Citizens Telecom.[37]

More recently, several state commissions and legislatures are considering measures to divest wholesale network services of incumbent local exchange companies (ILECs) from their retail service operations. In a leading case, the Pennsylvania Public Utility Commission has imposed 'functional separation' between the wholesale and retail divisions of state's Bell company, Verizon-Pennsylvania.[38] Other states are currently considering structural separations along these same lines.

Clearly, pressure was mounting on administrative and legislative institutions to reform local exchange regulation. The successes registered in federal deregulation of several other network industries–airlines, natural gas transmission, trucking and rail service–set the standard for the telecommunications industry. The successes of individual local competitors demonstrated that facilities-based competition was possible—competition that represented innovative entry and not just cream skimming.[39]

Potential models for reform of local exchange regulation were drawn from many corners of the industry. State-level experimentation with telecom regulation offered a range of alternatives, including some highly innovative and radical policies such as deregulation-cum-price caps in Nebraska and Vermont's 'social compact.' On other occasions, the U.S. imported regulatory models from abroad. The best example here is the price cap mechanism applied to British Telecom (BT) in the U.K. After applying price caps to AT&T in 1989, the FCC extended its use to the largest local telephone companies for selected interstate services. Soon afterwards, many state commissions and legislatures adopted some form of price cap regulation to intrastate services. The evolution of this policy now added features such as revenue sharing. During the 1990s, the majority of the states adopted incentive regulation in various forms.[40]

These reforms were aimed at moving rate levels and structures closer to cost; they were not designed to affect directly the level of competition in local service markets. A series of FCC initiatives took steps toward generating more local competition by reducing entry barriers or otherwise facilitating entry. First, in 1980 the FCC issued its non-dominant carrier

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[36] Rochester Telephone Co. (1993).

[37] As of end of 2000, 11 facilities-based carriers and 3 resellers accounted for 27 *percent* of the local exchange lines in the Rochester area. See New York Public Service Commission (2001).

[38] "Re: Structural Separation of Bell Atlantic-Pennsylvania Retail and Wholesale Operations," Pennsylvania Public Utility Commission, Docket No. M-00001353, March 22, 2001.

[39] At least in one instance, a backlash against competition was mounted when AT&T sponsored a 1975 bill to roll back competition (the Consumer Communications Reform Act). The bill was withdrawn 1½ years later after intense opposition from new entrants (e.g., MCI, Datran) and large users.

[40] Interestingly, there has been a significant incidence across the states of reversion to traditional RB-ROR regulation. In many cases, reform measures expired and, while a permanent incentive plan was often put in place, on occasion the state returned to traditional RB-ROR regulation. In some cases the reform plan was prematurely terminated. Frequently, the reason given was dissatisfaction with the outcome of incentive regulation experiment, often because of observed poor customer service. See Abel and Clements (1998) and the chapter by Sappington in this *Handbook*.

order that released qualifying providers from the burden of traditional rate filing and certification of facilities deployment. Second, formation of rules to give competitive long distance companies 'equal access' to local networks, and their implementation after AT&T divestiture, gave ILECs experience in inter-carrier relations. Third, the FCC adopted rules for provision of "comparably efficient interconnection" in its 1986 Computer Inquiry III decision. More groundwork for unbundling the public switched network would be laid when the Commission approves the BOCs' 'open network architecture' proposal in 1990. Finally, responding in part to petitions submitted by competitive access providers, the FCC ordered ILECs to provide facilities-based local competitors 'expanded interconnection' for dedicated and switched services in 1991 and 1992, respectively.[41]

At the state level, we saw earlier how progressive states broke new ground in creating institutions to accommodate facilities-based local competition. In New York and Illinois, the commissions and the carriers developed arrangements to permit competitive carriers to interconnect with Bell companies' networks. In the case of Rochester, the New York commission brokered a scheme that provided for wholesale provision of basic local network services as well as resale of local retail services to competitors, and now the Pennsylvania commission has separated the incumbent carrier along these same lines.

Experimentation with various policies aimed at creating local network competition had been incremental and sporadic. However, each experiment added to a national debate which was headed in the direction of a significant, widespread reform of the telecommunications sector. The momentum culminated in passage of the "Telecommunications Act of 1996" (TA96). Fundamentally, the 1996 Telecommunications Act embraced competition and deregulation as the best means to achieve efficiency in local telecommunications markets and to speed widespread deployment of advanced technologies and services. It explicitly rejected regulation as an obstacle to these objectives. The Preamble clearly and succinctly articulates this goal:

> "[The Act will] provide for a pro-competitive, deregulatory national policy framework designed to accelerate rapidly private sector deployment of advanced telecommunications and information technologies and services to all Americans by opening all telecommunications markets to competition..."

TA96 created several new breeds of local network competitors, and facilitated expanded competition in many ways, that we will discuss below in much more detail.

2.3 The Experience Abroad

In some respects, development of the local telephone industry abroad followed much the same early pattern witnessed in the U.S.: a Bell-like monopoly prevailed during which time the first telephone networks were built, first the local exchanges and later the long distance networks. The departure came at the end of the patent monopoly period. In almost every country outside the U.S., the industry was nationalised or absorbed as a government function, typically the post office and sometimes also national banks. These so-called 'PTTs' (for Post, Telephone & Telegraph) were fully integrated into provision of long distance and

[41] FCC Docket 91-141, Interconnection with Local Telephone Company Facilities, September 23, 1991.

international services. In most cases, however, they did not integrate into equipment manufacturing as did AT&T.[42]

For decades the state-owned telecommunications carriers operated without any threat of competition; independent regulation was irrelevant. The privatisation movement changed all that, and that movement got kicked off when the Thatcher government in the U.K. decided in 1982 to sell off British Telecom. Nationalised in 1911, BT was privatised in 1984.[43] Up until 1991 only Mercury Communications was allowed to compete with BT in local and long haul markets. When competition was allowed in local service, it was the nascent cable industry that offered the most direct competition by building their networks to provide voice telephony as well as entertainment video. As of September 2000, U.K. cable firms had signed up over 5½ million business and residential fixed lines providing local telephone service, or 15.8 percent of the nation-wide total.[44] Access provided by fixed wireless technology has met with much less success in the U.K. Up to recently, BT had been banned from both cable and fixed wireless businesses with the goal of promoting alternative access networks.

To regulate rates charged by the privatised BT, the British government devised a system of 'price caps' and charged the newly created regulator, the Office of Telecommunications (OFTEL), with overseeing its implementation. It deliberately rejected U.S.-style rate-of-return regulation as administratively cumbersome and detrimental to incentives. Price caps were applied initially in the U.K. to long haul services. When they crossed the Atlantic in 1989, they were applied by the FCC to AT&T's long distance service first, and then soon afterwards to certain interstate services provided by large local exchange carriers. Some form of price caps, generally referred to as 'incentive regulation,' spread across the country, and each state personalised their implementation by adding certain special features.

On the continent, a variety of alternative competition plans were being implemented, but these were occurring at a much slower pace, usually dictated by the European Commission. That was the case in Germany. The first steps toward competitive telecommunications markets came with liberalisation of CPE in 1988 and the awarding of two GSM licenses the following year, one of which went to the state-owned PTT, Deutsche Telecom (DT). It was not until 1995 that DT was incorporated, however, and then partially privatised in 1996, and it was not until 1997 that an independent regulatory body was created.[45]

On the opposite side of the world, a radical restructuring experiment had long been underway. Implementing the Telecommunications Act of 1987, the New Zealand government carved out telecommunications operations from its postal service and banking department, and called it 'Telecom New Zealand' (TNZ). A couple of years later TNZ was privatised and sold to two U.S. RBOCs, Ameritech and Bell Atlantic. Similar to BT, TNZ remained vertically integrated in local, long distance, international, wireless and other services, but not in cable services. While TNZ's privatisation was not extraordinary, the government proceeded to open wide every telecommunications market in the country.

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[42] Nevertheless, the PTTs usually completely controlled nation-wide sale and leasing of customer premise equipment and so held monopsony power over purchasers of that equipment.

[43] Although it was not until 1997 that the British government sold off its remaining interest in the company.

[44] OFTEL (2001).

[45] Ruhle (1999).

Licenses to provide service of any kind were freely issued. No communications-specific regulator was created. Instead, New Zealand's 'light handed regulation' of telecommunications encouraged private negotiations between carriers to establish interconnection arrangements and facility sharing. No pricing methodology or institutions were prescribed to govern these negotiations, only that the outcome did not have dominant carriers (in this case TNZ) violating competition law.

Clear Communications—a *de novo* entrant into long distance service partly owned by MCI initially, and then wholly owned by BT—was the first to build local and long distance facilities and request interconnection with TNZ. The protracted negotiations and ensuing litigation constituted the world's first test of unregulated markets in the mature telecommunications industry. Clear charged that, in demanding rates to terminate traffic on its network, TNZ had used its dominant position to exclude competitors from the long distance market–a violation of New Zealand's 1986 Commerce Act.[46] TNZ replied that its rates were not anti-competitive because they were consistent with the Efficient Component Pricing Rule (ECPR) which had the property of inviting new competitors if and only if they were more productively efficient than the incumbent. The case eventually was appealed to the British Privy Council which concluded that TNZ pricing was not unlawful three years after the initial complaint was filed.[47] Such legal disputes have remained a fixture of New Zealand's telecommunications industry ever since. Litigation arose at each major incursion into TNZ's markets, as Clear moved into local business services, as BellSouth New Zealand entered with its nation-wide GSM wireless network and as Saturn Communication began delivering telephony over their cable system in Wellington. All this may change if pending legislation is passed that creates a telecommunications commissioner in the Commerce Commission.[48] If passed into law, this law would represent a significant reversal in New Zealand's commitment to light-handed regulation.

A radical opening of local telecommunications markets had long before commenced in another part of the southern-hemisphere in a country not much larger in size or population than New Zealand. Chile had pioneered local competition even before U.K. or N.Z. had undertaken privatisation and deregulation.[49] The state-owned local telephone monopoly, Compania de Teléfonos de Chile (CTC), lost its exclusive monopoly in 1979 and two competitors, CMET and CTM, were issued licenses to enter its markets two years later. Chile's 1982 General Law on Telecommunications threw wide open the doors to competition by liberalising licensing of competitors, mandating interconnection, and decontrolling rates.

Akin to the New Zealand experience, competition in Chile was inseparable from litigation. Nearly every attempt at entry was met with private suits, and on occasion,

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[46] Specifically, Section 36 which prohibited use of a dominant position to deter or exclude competitors or hinder competition.

[47] Telecom Corp. Of New Zealand, Ltd. V. Clear Communications, Ltd. Privy Council, 1994. Note that as a consequence of New Zealand's 1840 entry into the British Commonwealth, it submitted to the British legal system.

[48] Telecommunications Act 2001. Certain 'designated services' can be regulated if the parties to a sale cannot agree on the terms. In making a rate determination for "designated services," the Telecommunications Commissioner selects among the principles of TSLRIC, bill and keep, or a combination of the two. Initial prices for designated services are to be set by benchmarking against rates in comparable countries that employ forward-looking cost methodology or a form of bill and keep. Final prices are invoked only if some party appeals.

[49] For a history of Chilean telecommunications, and a detailed record of the competitive era, see Melo (1998).

Supreme Court challenges to the authority of Subtel, the regulator overseeing the interconnection arrangements. Unlike the case of the former state-owned incumbents in the U.K. and New Zealand, CTC dominated local and Entel dominated long distance services after their privatisation. In 1994, the two companies were allowed to enter each other's markets, provided they did so with structurally separate subsidiaries and did not exceed certain market share ceilings. The consequence of all these actions was significant competition in all telecommunications market, including local services. As of the end of 2000, at least seven competitors achieved an 18 percent share of local lines in the country.[50] This competition has been facilities-based, with sizeable overbuilds in the Santiago area, and despite the fact that unbundling and resale provisions were only recently put in place.

Restructuring and deregulating the world's telecom sectors is a work in progress. There is much that remains to be done before competition is a reality in the many local exchange markets. Nevertheless, the progress has been breathtaking. As one indication, in 1989, 26 of the 29 OECD countries had fixed network monopolies whereas the remainder were duopolies; by 2000, there were no monopolies in this group and 24 now had 3 or more local wireline carriers.[51] The progress in wireless was equally dramatic: none of the monopoly structures in 23 of the OECD countries survived through 1998.[52]

3. ECONOMIC CONDITIONS OF LOCAL NETWORK COMPETITION

3.1. Defining Local Services and Markets

Analysis of this industry should begin with a definition of the economic market. For this we use a modified version of the market definition articulated in the Federal Trade Commission-Department of Justice Merger Guidelines: the local network market consists of the smallest collection of communication services and geographic areas that include traditional local exchange services such that a small but significant and non-transitory increase in price (SSNIP) above the *competitive level* will be profitable for a hypothetical monopolist. To make this definition operational, we might begin with all retail switched services, both access and usage, supplied over the wireline network in a metropolitan area, and then consider a 10 percent increase in rates for all those services for a one-year period. If users readily substitute away from such 'plain old telephone service,' or POTS, then the services they switch to should be included in the market definition.

Wireless mobile service is an example of a potentially good substitute for POTS provided its price is not exorbitant. In fact, the wireless alternative raises an important point: the SSNIP profitability test should be performed at competitive rate levels, and not current rate levels. POTS rates are likely well below costs due to political desires to cross-subsidise local service. In comparison, for much of its history, cellular service has been priced high relative to its costs and relative to basic wireline service, making it less attractive as a substitute for POTS. For users, wireless may be unattractive relative to POTS, not because it is not functional (most would agree that wireless has greater functionality), but because it is too pricey.

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[50] Telefónica-CTC, December 2000.
[51] OECD (1999 Table 1.1) and OECD (2001 Table 2.1).
[52] OECD (2001 Table 1.1), op.cit.

On the supply side, mobile service providers could offer local exchange services in competition with wireline networks, but not without building new capacity in wireless local loops. Cable television networks may be in a better position to roll out service to the general population in response to a price increase. Cable telephony is being offered by most of the largest multiple system operators (MSOs) in the U.S. Whether it will scale up to the broader population in a reasonably short period of time remains to be seen, and so whether cable telephony offers a substitute for POTS on the wireline network remains an open question.

Increasingly, telephone companies and their competitors such as cable operators offer customers a package of services. Bundling blurs market boundaries because users may choose not to switch to avoid forgoing perceived benefits of one-stop shopping. Digital convergence—meaning the combination of different voice, data and video services on the same physical medium—allows carriers to expand their range of service offerings at relatively small incremental cost compared to building a stand-alone network. As a result, an increase in basic local rates may not cause a customer to switch to wireless mobile service because local service includes high-speed Internet access. On this flip side, many entrants–especially cable companies–view the possibility of offering customers multiple services over their network as a means to pry customers away from the incumbent, especially when incumbents cannot respond in kind due to line of business restrictions.

Demand-based and supply-based delineation of local markets can be correlated. As a given set of individuals become more dispersed over a given geographic area, the cost of supplying them will most likely increase. At the same time, their demand for communication may also increase since the alternative of face-to-face contact becomes more costly. In part, this was one of the reasons that, quite surprisingly, sparsely-populated rural areas of the U.S. had some of the highest rates of telephone penetration in the early days of the industry.

Determining the geographic boundaries is an essential exercise to focus analysis on local telecommunications markets and differentiate from long distance and other services. Strictly speaking, users desire connections between specific originating and terminating points, so that these unique pairs define a unique service which does not have close substitutes. A slight change in terminating station will invariably result in no value to the user as in the case of dialling a wrong number. Adopting this definition of a service, however, makes the overall number of services astronomical.[53]

Individuals do not wish to communicate with every other individual on the planet, but they do place calls throughout the country and possibly the world, and they do value the option of being able to call any number sometime in the future. Because people tend to have more numerous social and commercial relationships with individuals and businesses that are close by, a vast majority of calls are made within the local geographic area. This is especially the case of local businesses that have a physical local presence, e.g., banks, retailers, utilities, schools, and governments. Of outgoing residential calls in the U.S., 84.4 percent are local, 2.8 percent are local toll and 12.8 percent are long distance.[54] For this reason, in the aggregate, we may take geographically local markets as service provided within a contiguous population centres, such as a metropolitan statistical area. Census Bureau and Rand McNally

[53] As an example, if there are *n* users, then there are *n (n-1)/2* bi-directional pairs, and so with a billion terminating lines worldwide we would have 500 trillion unique products.

[54] FCC, 1999 Statistics of Communications Common Carriers, August 2000. Note that no account is taken of type of call (voice, fax), or its distance, duration, and time of day.

definitions of population centres better approximate such markets than the LATAs drawn by the MFJ court.

Strictly speaking, the term local varies from one individual to the next: it will be an area in which their home (and possibly their place of work) is centrally located. With wireless mobile service, the position of the individual is no longer fixed, in which case the centrally located position may well be along a highway between home and work and shopping areas. When delineating the market, we will consider a change in price of local service throughout a region and the aggregate response of individuals living in that region.

Cost of supply of local services is very dependent on the geographic extent of the market. This is certainly true for traditional wireline networks where the length of the loop directly determined the cost of providing a user with access. Other technologies make distance less relevant. The cost of providing fixed wireless access, for instance, does not vary by the distance between the transmitting tower and the customer location up to the point where the signal attenuates. Also, with a ring architecture, service becomes unrelated to distance since traffic between two neighbours on the ring may travel its entire length.

With the proliferation of service options, substitution patterns among offerings become more complex. Connections may differ in their content (voice, video, image/fax, data), mobility (stationary, nomadic, high speed mobile), and bandwidth. As an example, wireless mobile services (e.g., PCS) have recently closed the gap with wireline service by adding custom calling features (call waiting, call forwarding, ANI), paging, voice mail, and now email and web pages. As a result we can expect greater substitution away to wireless should the price of wireline increase.

One final way to delineate local markets is by the customer type. The crudest distinction is between business, residential and carrier. In some cases there is little distinction as when either businesses or households wish to subscribe to mobile wireless service. But in other instances, one customer has no demand for a service that the other values highly: e.g., households have no demand for PBX trunks, and neither households nor businesses purchase unbundled local loops like competitive carriers. Even that distinction has blurred as the ranks of self employed individuals working from home increase. Each category also has important distinctions due to both demand differences and the cost of serving them. For instance, there can be huge cost differences in serving urban and rural households, and scale economies to serving large businesses.

Vertical services are available that could displace some local *usage* in response to a price increase, though they all may employ local wireline *access*. One such service is voice messaging. Whether a carrier service or user supplied (i.e., an answering machine), voice messaging may substitute for calling—unless parties engage in telephone tag. Facsimile transmission is another service that could substitute for local usage; it is also likely to stimulate local usage as users substitute away from regular and express mail services and email. Email itself may provide an alternative for sending certain messages locally. It has been estimated that 55 percent of emails displace voice calls, though these are not necessarily local calls.[55] Finally, 'instant messaging' (IM) could eventually offer an Internet version of dial tone, as it eliminates the latency associated with e-mail and yet captures a community of

[55] See Anderson et al. (1995) citing an Electronic Messaging and Micro Systems journal study in Huber (1987).

interest.[56] Surprisingly, the 'dual system' which predominated in the era of local phone competition, persists today with IM as AOL deliberately blocked compatibility with other IM networks.[57]

How do we measure local exchange competition? Whatever yardstick is chosen, end users should be the judges. If they get lower prices, better quality, greater variety and innovation, then market conditions are competitive even when the structure may remain quite concentrated. We might divide the different answers to this question into measures of inputs and outcomes. Among the inputs are structural and behavioural conditions. Outcome measures can be divided by whether they track the success of entrants or weigh the competitive impact on incumbents.

We lack subscriber data sufficiently detailed to compute traditional structural measures of concentration for each local network market such as the HHI. CLECs currently offer fixed telephony service in 56 percent of zip codes which amounts to about 88 percent of the U.S. population.[58] Nevertheless, active local lines provided by CLECs number about 16.4 million as of December 2000, or a mere 8.5 percent of the U.S. total.[59]

In crafting the TA96, Congress deliberately refused to measure competition in terms of market share, the number of providers, or any other quantitative yardstick. Alternatively, we might look for behavioural conditions that are conducive to competition. A good example of this approach is the 14-point checklist for local competition found in Section 271 of TA96. Among other items, the list requires incumbents to supply competitors with physical interconnection and non-discriminatory access to rights of way, poles and conduits. These conditions do not ensure competition will occur; they are believed to increase the likelihood of entry when they are met.[60]

It has become typical to measure competition in terms of the acquisition of market share by entrants. This can be measured by more traditional measures of competitor success such as sales and profit. In the specific case of local competition we record the number of phone numbers ported to competitors, collocation agreements and number of wire centres covered, unbundled elements supplied (loops, ports, trunks, switching) or resold lines. Alternatives to such output measures of competitor success are measures of investment in fibre miles, customer lines, and switches installed. By one measure, CLECs had 16 percent of local fibre miles as of the end of 1998, but only 1.8 percent of the customer lines and 2.4 percent of local revenues.[61] In addition to the fact that CLECs must build infrastructure in advance of signing up customers, this mismatch attests to how incumbents can benefit from customer inertia.

A weaker structural test would assess evidence of potential competition. This would be the number of potential rivals in adjacent markets such as cable and wireless service

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[56] Nick Wingfield, Changing Chat: Will Instant Messaging be the Dial Tone of the Future? Wall Street Journal, Sept. 18, 2000.

[57] In the Matter of Applications for Consent to the Transfer of Control of Licenses and Section 214 Authorisations by Time Warner Inc. and America Online, Inc., Transferors, to AOL Time Warner Inc., Transferee, FCC Cable Services Docket No. 00-30, Memorandum Opinion And Order, January 11, 2001.

[58] FCC, Local Telephone Competition: Status as of December 31, 2000, May 2001.

[59] Ibid.

[60] The Act allows ILECs seeking to enter interexchange service to follow "Path B" in which competitors have not materialised despite the fact that the checklist is satisfied.

[61] Federal Communications Commission, Local Competition: August 1999 (1999, Chart 2.1 and Table 3.1).

providers, electric power utilities and incumbent local exchange carriers who are located in nearby territories. It would be important, however, to assess the degree to which these companies are committed to competing in this market, recognising that to sink investment in a physical network that extends throughout the local area (as with a cable TV franchisee) is quite different from merely reselling an incumbent's retail services.

Once faced with effective competition, we would expect incumbent monopolists to lose market share to entrants and to see their profits fall, as prices and sales are driven down. A by-product of this competitive pressure could easily be to spur the incumbent to cut its costs, improve its service quality and accelerate new product innovations. Tomlinson (1995) and Woroch (1995) offer some evidence that ILEC service reliability improved after entry of CAPs.

3.2. Demand for Local Network Services

An analysis of market demand for local services contributes to an understanding of this industry in several ways. In the past, demand analysis aided regulatory commissions in determining the proper level and structure of local service rates. Price elasticities were used to make tariff adjustments and, more recently, cross-price elasticities guided the rebalancing of rates. Access elasticities are useful when evaluating initiatives to achieve universal service. As we enter a deregulated, competitive era, demand analysis is needed for other purposes. Cross elasticities now help in the definition of local service markets, a first step toward distinguishing services that are competitive from those that are non-competitive. When competition results in multiple viable suppliers, it is now important to measure *firm* demand functions (as opposed to market demand functions) to gauge, among other objectives, the extent of market power of current carriers and the effectiveness of competition.

Before launching into an evaluation of various demand studies, a few distinctions affecting local services are needed up front. First, it is important to distinguish between access to, and usage of, local services. Carriers compete differently in the two dimensions, as when wireless mobile matches wireline service by offering big buckets of minutes that begin to approximate flat rate tariffs. Second, we can differentiate basic services from 'enhanced' or 'vertical' services. Basic service refers to the collection of services that makes up POTS: dial tone, a phone number, local switched service, long distance access, white and yellow directories, directory, repair and emergency services, and billing. Enhanced services include custom calling features such as call waiting, call forwarding, number identification, plus voice mail and Internet access. Finally, users may need to buy necessary equipment (telephone handsets, inside wire, PCs, facsimile and answering machines, set-top boxes, software) in addition to the service itself.

Since most demand analyses are based on market data, it is necessary to understand how local services are priced. In the U.S., most users subscribe to basic local service for a fixed monthly fee that includes unlimited calling within the local area.[62] The amount of the flat rate varies depending on the size of the local calling area selected by the subscriber. Typically, ILECs are required by state commissions to set the same rates throughout their

[62] An alternative to the subscription system is prepaid service, a billing method that has become popular for mobile wireless and long distance services but not for local service. As an example, OFTEL (2000a) reports that 3 in 5 mobile customers in a U.K. survey use prepaid service.

serving territory. An alternative to flat rate service is measured service, which has the subscriber paying a smaller monthly fixed charge, and an additional amount based on usage (measured by calls or minutes or message units), usually with some calling allowance. Measured service is an option for residential users throughout the U.S., though in New York City and Chicago it is mandatory. Business users are usually charged on a usage basis for their outgoing calls, and pay significantly higher monthly subscription fees compared to residential users.[63]

To get an impression of access and usage of local services, the average U.S. household spent $398 in 1999 on basic local service, or about half of the $830 spent on all telecommunication services.[64] This figure translates into 1.12 percent of average American household expenditures on all goods and services in that year.[65] At the end of 1999, 193.9 million local loops were in operation in the U.S., of which 127.8 million were residential. In total, 99.1 million American households had telephone service by July 2000, making for a national penetration rate of 94.4 percent.[66] The average U.S. household with telephone service had 1.21 fixed lines.[67] During 1998, the average American local loop had 60 minutes of use per day, where 45 minutes, or 75 percent, was local calling.[68] As of the end of 2000, there were over 109 million mobile wireless subscribers, so that, on average, roughly 40 percent of the U.S. population had mobile wireless service.[69]

Given the opportunity, researchers would prefer to examine access and usage decisions by conducting a controlled experiment in which businesses and households faced various service and price options. Users would choose among two of more service providers representing various technological alternatives, and each would offer different calling plans, contract terms, and service packages. To get directly at the issue of local competition, we would like to track purchase behaviour over the time when the industry transitions from monopoly to more competitive structure. Such an ideal experiment has not been conducted, and will likely never occur. Instead there is much to learn from patterns of consumer behaviour under traditional monopoly structures, but also from early experience with local competition and with wireline-wireless competition.

In a classic econometric study of local access, Perl (1983) estimated the demand for subscription to the PSTN. Using data from the Census Bureau's 1980 Public Use Sample, Perl estimated a discrete choice model of demand for access based on rates (at the wire centre level) and demographic characteristics. He found probit coefficients on monthly subscription rates in the range of −0.0175 to −0.0492.[70] Income effects were relatively more sensitive compared to the price effects, having a probit coefficient of +0.1296, while the installation charge effect was quite inelastic at −0.0034.

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[63] This may or may not be price discrimination since, although the services are identical technically, it costs more to serve businesses due to their higher calling volume that typically occurs during peak hours. Volume discounts built into multi-line plans and Centrex and PBX trunks may compensate businesses for high mark-ups on their basic service.

[64] Federal Communications Commission, Trends in Telephone Service (2000).

[65] Ibid.

[66] Ibid.

[67] Federal Communications Commission, Trends in Telephone Service (2000), op.cit. Note that this figure ignores residential telephony delivered by other media such as a part of cable modem service.

[68] Federal Communications Commission Trends (2000) op.cit.

[69] CTIA (2001) and U.S. Bureau of the Census, Monthly Estimates of the United States Population: April 1, 1980 to July 1, 1999, with Short-Term Projections to November 1, 2000.

[70] These are logit coefficients; not usual price elasticities.

The study of access demand can answer questions about telephone penetration and the most effective means to promote universal service. Quite apart from any goal of distributional equity, one reason to promote widespread access to the local telephone network is to take advantage of 'network externalities.' These occur when each subscription confers a benefit on all existing subscribers because they can now call, and be called by, the new subscriber. This so-called "network externality" is increasing in the number of users connected (as well as their intensity of use). Certainly in the early days of the telephone industry users considered who might they be able to call when subscribing to phone service. Similarly, users who lived in cities with non-interconnected dual systems were very concerned about relative sizes of the competing local networks. More recent examples of network externalities in the communications industry include the adoption of facsimile machines and email services.

In his study, Perl (1983) found that demand for residential access was increasing in the density of phone subscription in a household's local calling area, confirming the presence of a network externality. The effect was small, however, as might be expected given the high U.S. telephone penetration rates during the sample period. Furthermore, unlike the earlier competitive experience, all networks were interconnected, further realising the available network externalities. Nevertheless, new services always appear on the horizon, some of which may substitute for local service and they may not be completely interconnected, as in the case of instant messaging.

Whether a household has phone service is not a terribly interesting question given the high penetration rates in the U.S. Instead, the question is what 'portfolio' of access lines a household will choose. A typical household may likely have two wireline phones (often with a second line reserved for a fax machine, Internet access and/or teenagers) plus a cellular phone and cable TV service. Each of these access media is a potential or an actual substitute for the others to the extent that they all can be used for voice and data communication, and in some case, video as well. Facilities-based competition, at least initially, is likely to supplement, and not entirely replace, current access lines to the household as usage is diverted from one medium to another.

Demand for access media other than the PSTN represent potential sources of competition such as fixed and mobile wireless access and cable TV service. When evaluating the competitiveness of these alternative access media, we must recognise that they could exhibit some network effects that will have the tendency to slow their penetration rates early until they approach critical mass. Relatedly, a new service (e.g., instant messaging over web-enabled wireless phones) will tend to obey the typical S-shaped diffusion curve as users learn about the technologies, incorporate them into their daily lives, and make necessary complementary investments that replace existing equipment and services. In both cases, the observed migration from incumbent network and reductions in usage are at least partially independent of the relative pricing of the services.

Turning to local usage, the scarcity of measured service in the U.S. makes for limited data to estimate price and income effects. An exception was a two-year field experiment conducted by GTE in 1977 which sought to analyse household response to mandatory measured service in three small towns in central Illinois. Residential subscribers paid varying rates for each call and for each minute of a call. Monthly data were gathered on both the number of calls and the total minutes of use by each household. Using these data, Park,

Wetzel and Mitchell (1983) estimated the per-call price elasticity of number of calls to be −0.076 and the per-minute price elasticity of usage as −0.055.

Responsiveness to usage-sensitive local rates have a profound impact on the take up rate of new services and, hence, revenue models of new communications ventures. Arguably, the U.S. witnessed rapid Internet adoption through dial-up modem connections, in part, as a result of the prevalence of flat-rated local service. In time, ISPs also adopted flat rated pricing. An immediate consequence is that the typical call to an Internet service runs about five times as long as the average voice call. In contrast, Europe (and other regions) have lagged in Internet adoption and usage, in part, because users must dialup over measured local service. Flat rated or free ISPs provide European Internet users with some relief.

Local usage is dependent on who is paying for the call. Both parties likely benefit from a call, so that if just one party pays, it confers a 'call externality' on the other.[71] Typically, wireline service adopts a 'calling party pays' (CPP) system that charges the party who initiates the call. Toll free numbers and collect calls reverse the charges to the called party. An important exception to CPP is wireless service in the U.S. where the mobile user pays airtime charges for both incoming and outgoing calls. It has been argued that this system is one reason for slower penetration rate of wireless service in the U.S.—despite its earlier introduction—especially relative to Scandinavian countries and Japan.[72] It is also likely to retard the spread of wireless Internet usage relative to CPP countries.

To date, econometric demand studies have focused, out of necessity, on local access and usage purchased from a regulated monopoly provider. As a consequence, these studies are silent on a number of important issues raised by local competition. For instance, the typical demand model in the Perl tradition lacks prices of substitutes whether they were the new access methods, such as cable telephony, or more traditional alternatives like paging or payphones or cellular mobile. It is too early to point to empirical models of consumer substitution among local providers but there is a body of evidence that has emerged that looks at competition among providers of short haul (interstate, intraLATA) toll. Taylor (1999) finds an intraLATA demand cross elasticity of +0.23,[73] indicating that residential consumers are willing to shift usage away to some extent from their local exchange provider to a competitive intraLATA supplier. In study of wireline-wireless substitution, Ahmad, Ward and Woroch (2000) find household willingness to shift local toll usage from wireline to mobile wireless service. Neither of these local toll studies examined substitution among access alternatives. A promising research area is an understanding of consumer local access and usage response when presented with competitive alternatives.

This exercise will be complicated by the fact that, as a consequence of competition, carriers offer users a plethora of calling plans and service packages. Enabled by digital convergence, and pushed by competitive urgencies, carriers have begun to offer business and residential users bundles of communications services at attractive rates relative to purchasing the individual services separately. In a competitive environment, it will be crucial to understand the ability of entrants to break into local service markets by offering a bundle of services, and of incumbents to retain customers in response to competitive threats. In an

[71] A call externality would occur with data services when a dialup connection would benefit both the client and the server even though just the user or the Internet content provider may pay for it. See Taylor on "Customer Demand Analysis" in this *Handbook*.

[72] See also the chapter by Hausman in this *Handbook*.

[73] Taylor (1999, p. 13).

early contribution to understanding this strategy, Kridel and Taylor (1993) estimate consumer response to the bundling of two custom calling features. More complicated than consumer response to a package discount, however, is the extent of consumer interest in purchasing multiple services from an integrated supplier, rather than various specialised providers. If there were evidence that consumers valued 'one-stop shopping,' then we would have some basis for this popular strategy that has led to huge cross-media mergers and expenditures on network retrofits.

This brings us to the issue of consumer willingness to switch providers when competitive alternatives come available. Earlier we discussed various sources of consumer inertia such as cost of switching phone numbers. Policies will eliminate some of these costs as when number portability is completely implemented. Many other sources of inertia remain, however, and it is important to determine the extent of this inertia to, among other objectives, evaluate the feasibility of competition and its likely pace. In a series of reports, OFTEL in the U.K. has conducted several consumer surveys to better understand the extent of switching and its determinants, within and between wireline and mobile alternatives.[74] Predictably, these studies find that the prospect of reduced charges was the main enticement for consumers to switch providers or technologies, and that satisfaction with current supplier is the principal reason for loyalty. Another area of demand analysis opened up by local competition is the study 'dual subscription' to multiple providers.[75]

3.3. Cost of Local Service and Technical Change

The technology of local service provision, and the resulting costs of production, are instrumental in determining whether competition is feasible and desirable in local service markets, and what form it will take. It is common to refer to the amalgam of various parts that deliver the traditional voice and data services as the PSTN.

At a basic level, local service provision, like so many communication services, is delivered by a network that is composed of links and nodes over which traffic of various kinds travels. The nodes of the network are individuals with their phones, faxes, personal computers with modems, and answering machines, and similarly, businesses with their PBXs, LANs, and email and web servers. The public network is full of nodes as well; these are made up of central office, remote and tandem switches, and main distribution frames and cross connects. The links that connect the various nodes are the copper loops, coaxial and fibre cables and radio connections. The carriers supply the inter-office trunks, feeder and distribution plant, and inside wire. Information that is electronically encoded as analogue or digital signals travels over the network. This information may be voice, data, facsimile, or video; it may be one-way or interactive, or broadcast; it may be switched (either circuit or packet) or unswitched.

Historically, the PSTN has been viewed as monolithic in the sense that a single provider builds, operates and maintains the network from end to end. Certainly this is the model that AT&T successfully promoted under Theodore Vail's direction and that the PTTs pursued outside the U.S. The PSTN was nevertheless designed to be modular in the sense that it

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[74] Oftel (2000a,b,c).

[75] Oftel (2000d pp. 4-5) finds in one survey that 7 *percent* of households with a fixed line subscribe to two fixed-line local providers, more often than not BT and a cable operator.

could be decomposed into parts that readily inter-operate, provided the parts adhered to Bell interface specifications. The network was not open, however, in the sense that a third party could unilaterally attach equipment to the network or run traffic over it. AT&T turned to outside vendors for some pieces of equipment but only when they met AT&T's engineering standards. By and large over time, AT&T ferociously guarded access to its network as when it banned placing plastic dust covers on directories arguing that this was necessary to ensure network integrity! Under these conditions, competition will occur only if a competitor builds an alternative network and poaches the incumbents' customers. An alternative, if not complementary approach, is to open up the existing network and allow competitors to purchase its services as inputs to their offerings.

3.3.1. Scale and density economies

Communications networks experience strong scale economies, in part, a consequence of the relatively large fixed cost associated with establishing links. Wireline links require one-time expenses of acquiring rights of way, burying conduit, erecting poles and stringing cable. Wireless links have even stronger scale economies: once spectrum is acquired and a transmitter tower is in place, variable cost is negligible for reaching customers within the range of wave propagation. Beyond the costs of establishing a given number of connections, we might expect production to obey constant returns to scale as the network is replicated to cover a wider territory.[76]

Scale economies are indicated when average cost exceeds marginal cost. Before checking this relation, a preliminary question is: What is the basic unit of output to measure the cost of local services? It could be an additional minute of talk time or an additional call; it could mean a second line to a household or adding a household to the network. Whether empirically there are scale economies will be sensitive to the choice of units.

Often it is claimed that there are no variable costs to delivery of local services. This is wrong for several reasons. First, even while the overwhelming majority of costs are durable investments, the plant and equipment have very sharp capacity limits, and as those limits are approached, shadow cost of capacity expansion rises.[77] Second, the variable costs of running a local network entail customer acquisition and care. Typically, customer acquisition costs in competitive cellular telephone markets range from $300 to $500 per subscriber. The importance of these costs grow as customer churn increases and the average tenure of a customer falls, as will surely occur as local services become more competitive.

Within a given territory, however, the investment cost per wireline will tend to decrease with population density. As density increases, the average loop length falls as nodes on the network become more closely packed. Of course, this requires that switching and terminal expenses do not outstrip the savings in transmission investment.

[76] 'Lumpiness' of network investment poses a countervailing force to constant returns to scale. Many components of modern networks, from fibre sheaths to digital switches to transmitter towers, are available in indivisible, minimum sizes. As a result, networks are built to a capacity that exceeds current demands and excess capacity persists.

[77] See Woroch (1987) for an expression for this cost. Mitchell (1990) provides engineering estimates of this shadow cost.

Switching and transmission investment substitute for one another.[78] Consider the simplest 3-node network. Complete service can be achieved by building a link between all three possible pairs of users. This 'mesh' architecture requires investment in three links and no switching. Alternatively, a switch can be installed at one of the nodes, allowing the network to eliminate the link not connected to the switch and re-route traffic between that pair of nodes indirectly through the switch. The load on the remaining two links, of course, will be heavier by the amount of the indirect traffic. Alternate routing of this sort economises on transmission and is the basis for the circuit switched network.[79] Airlines realised these economies when they adopted their current 'hub and spoke' route structure.

With large shifts in the relative costs of transmission and switching, the architecture of telephone networks adjusts to economise on construction expense. In the 1880s when switching was manual and cumbersome, wiring was so heavily used in large cities that they blocked out sunlight in the densest areas.[80] In the 1980s, when electronic switching became increasingly affordable, and while fibre optic transmission was still costly, telephone companies began to migrate toward a double-star network topology–at least when wiring newer neighbourhoods. By locating remote switches and digital loop carriers between central offices and customers, and by replacing the feeder plant with high capacity trunks, the carriers substitute switching for transmission.

More generally consider design of a network to connect n nodes. A complete network with a separate link connecting each pair of nodes would require $n(n - 1)/2$ links in total, but no switching. If, instead, a single switch is installed, then only n links are needed, one loop connecting each node to the switch. The question then becomes whether the savings of $n(n-1)/2 - n = n(n-3)/2$ links exceeds the additional cost of a switch (plus the additional cost of necessary transmission capacity on the n links to handle the greater traffic).

The trade-off between transmission and switching is dependent on more than the number of nodes and the relative cost of switches and cable. It also depends on the dispersion of users. To see this, consider a 4-node network in which users are located at the corners of a rectangle with height L and width $1/L$. By design, there are four users per square unit. With L near 1 (*i.e.*, a square), it makes sense to locate a single switch at the centre. As L gets large (*i.e.*, the rectangle becomes elongated with two pairs of users separated from one another), and as long as there is no cost of capacity nor any capacity limits on the links, it becomes economical to install a second switch, locating the two switches at the far ends of the serving area.[81] Here we see how a disperse population justifies multiple switching centres connected by high capacity trunk lines, as is typical of the PSTN. It also illustrates how population

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[78] See the chapter by Sharkey in this *Handbook*

[79] See Sharkey (1982).

[80] The urban blight that resulted led to bans on above-ground wiring in New York City as mentioned above.

[81] If a network has a single switch, it is optimal to place it in the centre of the rectangle, in which case the cost of building the network will be: $S + 4F + 4c(L^2 + 1/L^2)^{½}/2$ where S is the cost of a switch, F is the fixed cost and c is the unit cost per mile of installing a line, and $(L^2 + 1/L^2)^{½}/2$ is the length of each local loop. When there are two switches, they are located between the two close users at the short edges of the rectangle. Then the network cost is: $2S + 5F + 4c(1/2L) + cL$ where a fifth trunk line connects the two switches. Two-switch architecture is less costly than a one-switch architecture when the transmission cost saving exceeds the cost of the second switch and the fixed cost of the interoffice trunk: $2(L^2 + 1/L^2)^{½} - (2/L + L) > (S + F)/c$. A necessary condition for this to occur is that $L > 2/3^{½} \approx 1.155$ so the population dispersion does not have to be terribly great to justify a second switch.

dispersion can present profit opportunities for entrants who can efficiently serve individual switching centres provided inter-exchange trunking is available.

3.3.2. The Natural Monopoly Question

The main reason for our interest in scale economies of local services is to help determine whether the industry is a natural monopoly, and so evaluate claims that competition will harm overall social welfare.[82] The cost-based definition says natural monopoly prevails if one firm can provide all amounts of service at a lower cost than could two or more firms. Formally, production cost must be subadditive at each level of output within the relevant range.[83] This is a strong, global test for monopoly to be the cost-efficient industry configuration. It is also static in that this condition is checked at a point in time, and assumes cost is not dependent across time.

It is felt that the scale economies that derive from large fixed costs of building different parts of the telephone network, especially local loops, feeder plant and interoffice trunks, ensure the local exchange will have costs that are (globally) cost subadditive. Evans and Heckman (1983) were among the first to empirically test for natural monopoly in telephone services. They analysed pre-divestiture AT&T using a two-product translog cost function, where the products are local and long distance services. Testing for sub-additivity of the cost function using 1958-1977 data, they failed to reject (local) super-additivity and they could not accept (global) sub-additivity. Extending Evans and Heckman's data to 1979, Röller (1990) estimated a CES-quadratic cost function—again for local and toll services—and accepted global cost subadditivity. Using accounting data submitted by the large local operating companies to the FCC over the pre-divestiture period 1977-83, Shin and Ying (1992) estimated a translog cost function. They found evidence of weak scale economies at the central office level, and concluded costs were not subadditive.[84]

It must be kept in mind that these and other econometric studies employ accounting cost data collected from highly regulated telephone companies. As usual, accounting measures depart from economic cost concepts. More important, these regulated companies are likely driven off their efficient production frontier by regulatory constraints.[85] These carriers are also protected from actual and potential rivalry that might otherwise drive them to be more efficient.

3.3.3. Scope Economies

Another important economy in local service provision is the savings from delivering multiple services from the local network. A distinguishing characteristic of the local network is the fact that it provides access to all kinds of service besides making local connections. Consequently, it is more efficient to share one local network across these services than building multiple networks. The industry learned quickly the high cost of this structure during the dual system era.

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[82] Faulhaber (1975).
[83] Baumol (1977).
[84] See also Shin and Ward (1993) and the Fuss and Waverman chapter in this *Handbook*.
[85] When telephone providers are state owned, no obvious objective motivates their supply behaviour.

Scope economies prevail when it is cheaper to provide two (or more) services by a single entity than by two (or more) firms each specialising in a single service.[86] At the source of the scope economy is a shared facility which, in the case of the local network, are various types of real estate (rights of way, radio spectrum, central office floor space), infrastructure (ducts, conduits, poles), transmission facilities (trunks, loops, towers) and switching equipment (including routers and servers).

Credible tests for scope economies in local network services are few. Several of the econometric studies of scale economies mentioned above test for the presence of scope economies. In each case the fitted cost function is simply projected out of sample to predict costs of a stand alone local service provider. Gabel and Kennet (1994) avoid this problem by employing an engineering optimisation model to estimate costs of providing local services. They find strong scope economies among switched services, as well as between switched and non-switched services.

One advantage of so-called 'digital convergence' is the ability to realise scope economies by combining several different transmissions on the same medium (when they had previously been carried on separate facilities).[87] Currently voice and data share parts of the local network (loop and trunks, but not switches or servers). The overlap between voice and video on the cable network is another example as voice simply occupies a low-frequency spectrum on the coaxial cable. Fixed and mobile wireless services have much less overlap, with wireless using the landline transmission facilities for traffic backhaul.[88]

Whereas the presence of scope economies argues for a single firm to produce a range of services, the benefits of specialisation can work in the opposite direction. Specialists can avoid the overhead needed to deliver a wider range of services and yet enjoy large-scale economies. It is a theoretical possibility and a practical reality that specialists find entry into narrow product markets profitable. The technical condition that holds when a service is vulnerable to specialised entry states that the entrant's stand alone cost of producing any level of the service up to market demand is less than the incremental cost to the incumbent of adding that service to its product line.

Common carriers are especially vulnerable to 'cream skimming' by entrants who offer services with the largest price-cost margins. Their supplier-of-last-resort obligation compels them to serve all customers under the prevailing tariff and to provide a full range of basic services throughout their serving area. On the other hand, users have identified benefits of buying from one supplier in the form of reduced transaction costs in billing, customer service, and technical support. So there may be economies of specialisation in production but benefits from one-stop shopping on the buyer side.

One last form of scope economy worth mentioning takes the form of cost savings when a firm integrates across two successive stages of production.[89] Such 'vertical economies' likely arise in the local services industry for provision of network carrier services (unbundled elements, bulk transport) and retail services (basic services, private line), and in turn, basic local service with certain vertical services (customer calling features, voice mail). As with horizontally related services, the presence of shared resources across stages is a prime source

[86] Panzar and Willig (1981).

[87] Katz and Woroch (1997) describe several other interpretations of the concept of digital convergence.

[88] Although a wireline network may terminate incoming wireless calls, and vice versa, provided the two networks are interconnected..

[89] See Spulber (1991).

of vertical economies. Sharing infrastructure–both physical and software–can reduce the overall cost of a package of wholesale and retail services.

It appears, however, that the savings to integrating upstream into network construction and equipment manufacturing is not great. It is in these situations that a specialist in a particular stage of the supply chain can make profitable entry. It offers a sound explanation for why local telephone carriers often outsource such activities as inside wire maintenance and billing and collection. There is also an important strategic reason why vertically integrated service providers have been divesting upstream operations as competition materialises downstream. AT&T divested Western Electric, now Lucent, mainly because its customers saw a conflict of interest buying equipment from a company with whom they competed in services.

An important property of telecommunications cost, especially infrastructure investments, is its 'sunkness.' Once completed, much equipment and facilities have little economic value in uses other than for what they are intended. Fibre cable buried beneath the street or pulled through underground conduit is literally and economically sunk.

Sunk investment has important strategic implications for local network competition depending on its size and who makes the investment. When incumbents invest in sunk facilities, they have incentives to cut price down to avoidable costs. Technologies that do not involve heavy sunk costs can be much more responsive to uncertain, changing conditions. For instance, wireless technology tends to be less sunk than wireline technology.[90] To the extent that transmitters can be moved or the system can be retrofitted for another wireless standard, wireless technology is cheaper to use. In contrast, cable TV companies have learned that a network optimised for one-way delivery of multi-channel video entertainment is not easily reconfigured to deliver two-way voice and data services.

3.3.4. Technical Change

Technology of local telecommunications, like any communications industry, is improving rapidly and unpredictably. What is certain, however, is that costs are falling and capabilities are expanding. Advances in microelectronics have lowered switching costs as price and performance of essential digital signal processing (DSP) and application specific processor (ASP) chips steadily improve. The relentless march of improvements in optical transmission has not only increased the throughput of a fibre while lowering the cost of manufacture and installation of fibre. As the performance-adjusted cost of switching and transmission fall together, how the trade-off discussed above will balance out remains to be seen. More important for our purposes, however, are the impacts that changes in scale economies have on local competition. Roughly, technological change has reduced overall costs of providing local services, but with an increase in fixed costs relative to variable costs. On balance, the effect on competition is ambiguous. An entrant that adopts new technology, thereby facilitating entry can achieve lower costs; but the relatively higher fixed costs raise MES, reducing the number of viable firms. To complicate matters, new technologies often result in improved or enhanced service stimulating demand and likely supporting more firms.

[90] An exception would be the investment in certain kinds of spectrum licenses. If those rights were not transferable to other carriers and/or not portable to other locations, then the expenditures become more sunk, and accordingly they would fetch lower bids.

Digital switching and transmission have profoundly reduced costs and improved service of local communication networks. Digitalisation supports advanced signalling networks and switching features that expand the services offered to customers. Digitalisation also elevated the role of software in the local network. A typical digital switch is run by programs having more than a million lines of code enabling an expanding array of capabilities. Compression algorithms pack increasing amounts of information on an optical fibre (e.g., dense wave division multiplexing) or on a radio channel (e.g., 3G wireless standard), greatly relaxing capacity limits.

Compared to early times, the local network is not a permanent, static platform for service delivery. Local carriers can reconfigure switching and signalling software to launch new calling features unanticipated when the switch was first installed. In the case of business services, this control may be placed in the hands of the user. Carriers can also trouble shoot and maintain their networks electronically from a central, regional operations centre, reducing the necessary 'truck rolls.' As a result, reliability and security of wireline and wireless networks have greatly improved.[91]

The impact of innovations in network architectures on local competition is more difficult to predict. An example would be the deployment of fibre rings in urban areas rather than the traditional 'star network' with loops emanating from central office switches. Certainly this new architecture was a good fit for CAPs' strategy to enter by gathering high volume traffic in a densely populated business area. These networks economised on switching–relatively recently installing carrier-grade switches–taking advantage of the low cost and high capacity of fibre.

More recently carriers have been moving toward Internet Protocol (IP) architectures patterned off the way the Internet is configured. Whereas the traditional PSTN centralised network intelligence (switching and signalling), the Internet places intelligence at the edges of the network. The Internet is said to be made up of dumb pipes and smart terminals, compared to the PSTN where the terminals are dumb and intelligence resides in the network.

Packet-switched networks use of alternate routing is pervasive but with different implications for switching and transmission. In that case information including voice and other traffic are 'packed' at the source, and each packet is individually routed to its intended destination where it is reassembled in its original form. Compared to a circuit-switched network where a dedicated circuit is established between the source and destination, packet switching reduces the need for capacity along a route between the two nodes. The dynamic routing of packets allows the traffic to reach its destination when congestion or failure makes some routes unavailable. So far, synchronisation problems, high latency and poor security have limited the use of packet network to carry voice traffic.

Econometric studies using historical data cannot address questions related to the current and near term technologies of the local exchange, when technologies change so fast. Alternatively, engineering cost studies offer the promise of a look at the near-term future. By using current or projected prices for inputs and by adopting the best available technology and optimal architectures, these models aim to better predict costs that incumbents and entrants face at present and will face in the immediate future.

As with econometric studies that use data from monopoly industries, engineering cost models may be based on costs that reflect an imperfectly competitive industry. Pressures of

[91] Though centralised control, without adequate redundancy, can also raise reliability risks.

competition will affect pricing of equipment and other inputs, and also result in different equilibrium network architectures. In fact, engineering cost studies have been most prominently built and used for regulatory matters. For instance, the FCC developed the 'Hybrid Cost Proxy Model' to generate cost estimates for unbundled network elements (UNEs) which, in turn, would be used to set prices for these services.[92]

Current demand and cost analyses fall far short of informing the most urgent questions surrounding local network competition. Out of necessity, econometric modelling of these phenomena has had to rely on data drawn from incumbent monopolists and state-owned enterprises whose rates and service offerings were highly controlled. In the new era of local competition, what is needed are estimates of the costs of entrant supply as well as those for an incumbent who faces competition. This may involve a greenfield construction of a network, or it may rely on unbundled network services to varying degrees. The latter represent altogether new wholesale services that must be added to the incumbent's product line. In addition, the entrant will likely offer a different array of services than the incumbent. It is the reality, however that, as of yet, competition has been too limited and too brief to provide an adequate dataset to test these kinds of propositions.

4. THE STRUCTURE AND REGULATION OF THE LOCAL NETWORK INDUSTRY

4.1. Structure of the U.S. Local Exchange Industry

Supply of local telephone service has always been highly concentrated in a given geographic region, even during the early era of dual system competition. Today in the U.S., and increasingly elsewhere in the world, the emerging structure is one of a dominant incumbent facing an array of facilities-based and service-based competitors, including *de novo* start-ups as well as established firms entering from related network industries. Prominent among this latter group are long distance carriers, cable television systems and electric power utilities. Cable and electric power have facilities that overlap considerably with local exchange networks. The serving area of the large cable multiple system operators (MSOs), and major long distance carriers, also extend beyond regional presence of even the largest ILEC.

Concentration in local services can be measured against several alternatives, and depending on what segments are examined, the extent of competition can vary considerably. This is due to the fact that competition has taken hold in certain customer segments, service offerings and urban areas. The penetration of competition continues to grow in these markets, and has spread to other markets over time.

As of end of 1999, the four RBOCs together owned 88 percent of U.S. end-user lines with Verizon and SBC accounting for nearly two-thirds between them.[93] The RBOCs collected 94 percent of ILEC end user revenues.[94] While there are hundreds of small and mid size local exchange companies, they tend to have even larger shares in their markets than the RBOCs since their markets often can not support multiple carriers. At the close of 2000, CLECs provided 16.4 million lines or what is 8.5 percent of the 193.8 million of the nation's

[92] Sharkey (1999).
[93] Federal Communications Commission, Trends in Telephone Service (December 2000, Table 8.3).
[94] Federal Communications Commission, Statistics of Communications Common Carriers (2000, Table 2.9).

fixed lines.[95] CLECs owned 7.75 million of those lines, acquiring the remaining two thirds from ILECs as UNEs or resold loops. In 1999, CLECs as a group has sales of $6.5 billion, and had a cumulative average growth rate exceeding 87 percent over the proceeding eight-year period.[96]

The extent of local competition is greater if one were to treat mobile and fixed wireless services as competitors. Measured in terms of revenues, cellular and PCS carriers in the U.S. generated over $52.5 billion in 2000,[97] a figure that represents a third of the combined local wireline and wireless communications sales.[98] Now since many ILECs also own wireless carriers in their wireline serving territory, this last figure must be reduced to better reflect the relative size of wireless sector as a competitor to fixed line service.

The picture of concentration is much more varied if one looks at individual local markets. At one extreme, as has been typical, are the communications-intensive markets of the largest metropolitan areas. By the end of 2000, CLECs reported 2.95 million lines in New York state, accounting for 20.9 percent of the lines in that state.[99] Fully 93 percent of zip codes in New York state are served by at least one CLEC, and as many as 32 percent of them are served by 7 or more CLECs. This compares to a nation-wide figure of 56 percent of zip codes being served by at least one CLEC.[100]

Relative success of competitors also varies across customer types. At the broadest level, CLECs have been much more successful in winning business customers away from the ILECs. Only 41 percent of CLECs' lines are sold to residential and small business customers compared to 79 percent of ILECs' lines.

Competitive carrier share continues to grow at a rapid pace, starting from insignificant levels 10 years ago. During the year 2000, the number of CLEC resold lines and leased UNE loops nearly doubled while the number of ILEC end-user lines actually fell by 2 percent.[101] Nevertheless, the four RBOCs and the other ILECs have well over 90 percent of combined business and residential switched access revenues.[102]

The facilities-based competition that has materialised to date has employed traditional copper loop technology. By the end of 2000, of the 16.4 million competitive lines in service, only 1.1 million were delivered by coaxial cable and another 451,000 by fixed wireless.[103] Together, these two alternative technologies represent just 10 percent of CLEC lines and less than 1 percent of all end-user lines in the U.S.

At the same time that entrants into local network markets multiply and grow, the concentration among established carriers has greatly increased. A series of mergers transformed the largest eight U.S. ILECs into just four. In the two most prominent consolidations, SBC acquired, in order, Southern New England telephone, Pacific Telesis, and Ameritech, and Bell Atlantic acquired Nynex and then GTE to form Verizon. By and

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[95] Federal Communications Commission, Local Telephone Competition (2001).

[96] Federal Communications Commission, Local Telephone Competition at the New Millennium, (2000, Table 7).

[97] CTIA (2001).

[98] Calculated using Federal Communications Commission, Statistics of Communications Common Carriers (2000 Table 2.9) op.cit.

[99] New York Public Service Commission (2001).

[100] Federal Communications Commission, Local Telephone Competition (2001 Table 12).

[101] Federal Communications Commission, Local Telephone Competition (2001 Table 4).

[102] Derived by combining interstate switched access and state access revenues reported in Federal Communications Commission Statistics of Communications Common Carriers (2000 Table 2.9).

[103] Federal Communications Commission, Local Competition, (2001 Table 5).

large, these mergers were among contiguous regions, laying the foundation for providing long distance service over a wide region. The effect has been to increase concentration among local exchange incumbents at the national level and at the same time to increase scale and potential of threats to those markets. Both the SBC and Verizon mergers were approved with requirements that the companies meet a timetable for out-of-region entry into local exchange markets, with stiff financial penalties for missed deadlines.

Over the past decade, the long distance industry has invested significant sums of money to acquire facilities-based carriers who provide, or could provide, local services. AT&T made the largest expenditures on local service infrastructure. The company purchased one of the country's two largest CAPs, Teleport Communications Group and its largest cable company, TCI, plus a portion of MediaOne, a cable giant. MCI purchased the other large CAP Metropolitan Fibre Systems (MFS), in 1996 for $14.1 Billion, before buying two smaller ones, Brooks Fibre Properties and Intermedia Communications. The third largest long distance carrier, Sprint, purchased United Telephone, the independent local telephone company.

All three major interexchange carriers also took a large stake in wireless service, both fixed and mobile.[104] The cable industry took steps to prepare for its attack on the local markets. MSOs replaced their trunk network with optical fibre, and bought and sold or swapped properties to create contiguous clusters of franchises in urban areas. Attempts to join cable and local exchange companies were broadly unsuccessful and rarely as a means to enter out-of-region local exchange markets.

Established carriers, both incumbents and entrants in local services markets, are groping toward the most effective scale and scope. AT&T has come full circle in this regard: after being divested in 1984, the company entered nearly every facet of the local wireline and wireless market through acquisitions. Its expressed motive was to offer customers the full array of services with the convenience of one-stop shopping. Recently, AT&T has chosen to divest itself into four companies, each pursuing separate business lines.

Entrants into these markets have gone through several evolutions, first focusing on dedicated access services, and then switched services, and now Internet services such as web hosting. And whether incumbent or entrant, wireline or wireless, all carriers recognise the growth potential of data services, and the limitations of voice telephony, and to a lesser extent video services. The ongoing explosion in growth of data traffic could overshadow other threats to the PSTN. As usage shifts away from circuit-switched networks onto packet-switched facilities, revenue growth from Internet access could ensure the viability of cable, fixed wireless and satellite networks that could bundle in basic voice telephony at a negligible incremental cost.

To summarise, local network markets have historically been highly concentrated. One hundred years ago, in the first competitive era, residential and business customers had a real choice among carriers, although they sacrificed benefits from network externalities since competing networks typically were not interconnected. Local service customers, especially residential, have had much less choice in the recent episode of local competition, but they have realised the full benefits of interconnected networks. Five years after complete opening

[104] AT&T acquired the largest cellular company at that time, McCaw Cellular, and then later Vanguard Cellular. The other two major inter-exchange carriers went for fixed wireless acquisitions. MCI bought the fixed wireless firm CAI Wireless and Sprint bought People's Choice TV, American Telecasting, Wireless Holdings, and Videotron Bay Area.

of these markets, competitors have achieved roughly 6.4 percent of local revenue and lines.[105] This progress has been considered inordinately slow by many, but it must be put in perspective. By 1981, 10 years after it first began service, MCI had achieved a mere 1.05 percent share of domestic toll revenues.[106]

The reality is that implementation of competition involves a detailed, costly restructuring of a mature industry which consumes a considerable amount of time. Incumbent carriers did not have any significant experience with arranging inter-carrier sales of wholesale network services to competitors. Indeed, such inter-carrier transactions did not occur even in those services which were arguably competitive prior to deregulation. As such, the interconnection, unbundling and resale that underpins much of the current level of competition are unfamiliar and unnatural acts for the ILECs.

4.2. Regulation of Local Network Competition

No portrayal of the structure of the local network industry and its patterns of competition would be complete without discussing the regulatory policies imposed on these markets. Until recently, regulation was almost exclusively an issue for the U.S. local telephone industry since elsewhere local networks were state owned. World-wide privatisation of PTTs has spawned new regulatory agencies and institutions, and as a by-product, we have a richly varied experiment of alternative policies toward local competition.

Regulation of local network competition takes on many different forms. Some are direct in their impact on competition by facilitating or impeding entry, while others are more indirect by restricting how incumbents (and entrants) can compete in local services markets, and consequently their incentive to enter in the first place. Regulators face at least four distinct challenges, the combination of which is somewhat unique to local network competition.

First, they must decide whether structural competition is beneficial or whether, perhaps because of natural monopoly conditions, entry is not viable and potentially wasteful. Policy makers cannot know the efficient amount of competition without full knowledge of the cost conditions facing established firms and potential entrants. Difficulties in making this assessment are magnified when entrants (or incumbents) deploy entirely new technologies that lack any track record on costs.

Second, as with many network industries, competition in local services may require some time to grow to a size necessary to realise scale economies in both supply and demand. In the meantime, an entrant may require assistance or protection if it is to achieve viability. In comparison, incumbents have invested in local network facilities long before competition materialised. Economically sunk and ubiquitous, these networks can selectively and rapidly respond to entrants' forays with in any specific area.

Third, efficiency demands that services be provided over shared facilities, as happens, for instance, when local and long distance voice and data traffic travel over the same local loop serving a residential customer. The presence of shared facilities raises the issue of whether relative prices are structured to subsidise one service over another. The proper test is

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[105] Local Telephone Competition, op. cit.

[106] MCI's 1981 revenues stood at $413 million while total toll sales were $39.18 billion. See Trends in Telephone Service, FCC, Feb. 1995 at Table 30.

whether a service generates unit revenue that falls between its average incremental cost and its average stand-alone cost. A regulator seeking to subsidise some service or customer class, perhaps to pursue universal service, invites or deters entry in selected markets. One might question to what extent entry by CAPs was merely a response to cross subsidies built into switched and special access rates.

Fourth, and related to the previous point, sharing of facilities by different service providers can have a strong efficiency appeal. Even if two local providers do not overbuild one another, efficiency demands that they terminate each others' traffic, for otherwise users would be denied full benefits of the network effects. Pricing the use of these facilities–whether for the terminations of traffic or the leasing of facilities–must balance the incentives of competitors to enter local markets against the incentives for incumbents to maintain and replace existing facilities and to build new ones. In particular, should incumbent carriers be permitted to recover some or all of the historical costs of the facilities they are required to offer competitors? We do not address this difficult, crucial question in this chapter, or other issues related to the efficient level of interconnection prices.[107]

Agencies empowered with regulating local services have over time arrived at a division of labour. States have jurisdiction over local telephony and intrastate toll services, while the FCC regulates interstate toll and related services. Conflicts between state and federal regulators arise in large part because local facilities are shared by the different kinds of traffic. As one example, the FCC has decided that if more than 10 per cent of the traffic on a local facility was interstate, then the entire facility was treated as falling in the FCC's rate regulation domain. Using this rule, many CAPs were able to claim FCC jurisdiction and get out from under more restrictive state regulation. Increasingly, local governments play an important role in controlling local entry through their control of urban rights of way, conduit and ducts, and often impose franchise taxes on competitive local carriers.[108]

Cable television services also are principally the responsibility of the municipal authorities who awarded their franchises. The federal government did not become involved in the early days of the cable industry, with a few key exceptions. In 1972, the FCC ordered that new cable systems must be provisioned for upstream channel (anticipating cable telephony services).[109] The agency imposed its ban on cross ownership of cable and telephone companies in 1984, with the primary goal of keeping telephone companies out of video delivery. Congress also took the initiative to intervene in constraining basic cable rates. With passage of TA96, these rates were de-controlled in 1999. Even today, the regulation of cable is segregated from other communications services such as wireline telephony and wireless services in most regulatory agencies (e.g., Common Carrier Bureau and Cable Bureau at the FCC).

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[107] See the chapters by Armstrong and by Noam in this *Handbook*.

[108] The connectedness of various parts of the local network can cause deregulation to have unintended consequences. Often opening up one part of the product line to competition will create pressure on adjacent services. For instance deregulation of long distance created incentive to cut local access charges by spawning bypass operations and encouraging IXCs to integrate upstream into provision of local access. Deregulation of CPE created new means for users and competitors to bypass ILECs: the PBX substituted for Centrex, microwave links bypassed special access circuits, answering machines substituted for centralised voice messaging, and more recently, personal computers with modems facilitated "voice over Internet protocol" (VoIP).

[109] Cable Television Report and Order, 36 FCC 2nd 143 (1972) required that all future cable systems be designed to be two-way capable by setting aside a 25 MHZ band for "return traffic."

Supply of local telephone service has been treated as a *de jure* if not a *de facto* monopoly franchise by state authorities. Perhaps the lingering memory of dual local systems compelled the agencies to effectively block entry into switched local services to residential customers. These regulatory barriers are necessary to maintain low local rates deemed necessary to promote universal service, among other objectives. A complex system that combines rate of return rate making with fully distributed cost pricing drives a wedge between local service prices and their costs. It is generally accepted that, to varying degrees, intrastate and interstate toll rates have been a significant source of subsidies that finance the shortfall.[110] Within the local exchange, there is evidence that business access and usage rates subsidise residential rates,[111] dedicated access charges subsidise switched services, and custom local services, operator and directory services and yellow page directories all contribute to subsidies that support lower local rates. Pressure develops for entry where regulated margins are greatest, and because of economies of density, this usually occurs in the most populated urban areas.

Another important aspect of local rate making is the asymmetric treatment of incumbents and entrants. At least for interstate access services, entrants enjoyed non-dominant status which often meant they merely filed their tariffs for public inspection. Restriction on incumbents' rate setting can severely limit their ability to respond to competitive threats, and artificially inflate profitability of entry. The pricing flexibility that comes with many "incentive regulation" schemes re-balances this asymmetry to some extent.

TA96 takes significant steps to encourage entry by facilities-based local service providers with the following measures:

1. Mandating interconnection of networks at technically feasible points, including physical and virtual collocation of network equipment,
2. Furnishing other resources and services that aid in entry including phone numbers, dialling parity, rights of way, ducts, poles, databases, directories,
3. Reciprocal compensation for transmission and termination of calls across networks,
4. Eliminating legal barriers to entry into local telephony by: (a) relaxing the FCC's cable-telco cross-ownership ban; (b) pre-empting state and local regulations from creating entry barriers; and (c) exempting electric power utilities from restrictions by the Public Utility Holding Act.

The Act also opened entry routes into the local exchange by service-based providers by requiring:

1. Unbundling of network elements and supply at rates near economic cost (TELRIC),
2. Resale of retail services at wholesale prices equal to retail rates less avoided cost.

Entrants may also use any combination of these services to enter local exchange markets, along with their own facilities.

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[110] In the opposite direction, urban local rates clearly subsidise rural local rates if only because many states require geographic averaging even while costs of service are much higher in small towns and rural areas.

[111] Palmer (1992) finds that business basic service rates subsidised local service in Massachusetts.

At least initially, the Act has succeeded in stimulating entry of both kinds. Between the first quarter of 1996 and the end of 1999, the number of CLECs holding numbering codes increased from 16 to 275, with the numbers ported going from zero to 4½ million.[112] Over this same period, the combined number of unbundled local loops and resold lines has gone from zero to 8.3 million.[113]

To further encourage the RBOCs to open their regions to competition by implementing these measures, the Act extends the "carrot" of permission to enter in-state long distance service. An RBOC may get this LOB restriction lifted for a state provided they satisfy each item on a 14-point checklist as well as gaining approval by the state commission and the FCC. After several attempts, the first RBOC to succeed in getting FCC approval was Bell Atlantic in New York state in 2000. The long distance market has been opened to RBOCs in several more states since that time.

Whether the provisions of the Act will ultimately succeed in creating effective, sustainable competition for ILECs will not be known for years. After all, facilities-based long distance carriers and resellers numbered in the hundreds for many years after the opening of this market, even while AT&T never held less than half the market 30 years after the landmark MCI decision.

TA96 makes a special effort to encourage the deployment of new technologies.[114] Policies that promote new technologies are likely to favour entrants over incumbents. Typically new technologies threaten to cut short useful lifetimes of capital investments and to undermine incumbents' relationships with regulators. Furthermore, current interest groups–both suppliers and users–have vested interest in the rents protected by regulation, plus relatively low cost of organising their constituents and promoting their position. Compare that to entrants and their prospective customers who rarely have well defined interests (either not coincident or not known) and suffer from high cost of organisation. The outcome is a tendency for regulators to accede to wishes of incumbents and block new technologies that would facilitate entry.

TA96 has left its mark on local communications markets abroad as well. It provides a model that other regulatory authorities imitate, and learn from. Recently, the U.K.'s OFTEL imposed local loop unbundling on BT[115] and the European Commission separately embarked on specification of a similar policy.[116] These initiatives come after years of promoting infrastructure competition over service-based alternatives. It raises the question as to which form of competition delivers the highest social returns. The U.S. does not offer a clean natural experiment since local markets were opened to both forms of competition at the same

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[112] FCC, Trends in Telephone Service, March 2000, Chart 9.4, and Local Competition: August 1999, report by Industry Analysis Division of the FCC's Common Carrier Bureau, August 1999.

[113] FCC, Local Telephone Competition: Status as of June 30, 2000,Table 1.

[114] Later in Sect. 706(a) the Act instructs the FCC to "... encourage the deployment on a reasonable and timely basis of advanced telecommunications capability ... by utilising ... price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment." In a previous attempt to promote new technologies, the FCC amended Section §1.7(a) of the Communications Act in 1983 to read: "It shall be the policy of the United States to encourage the provision of new technologies and services. Any person or party who opposes a new technology or service ... shall have the burden to demonstrate that such proposal is inconsistent with the public interest."

[115] OFTEL (1999).

[116] European Commission, "Proposal for a Regulation of the European Parliament and of the Council on Unbundled Access to the Local Loop," 12 July 2000, Brussels.

time. In fact, a convincing interpretation of the Act's promotion of unbundling and resale of local services is as an attempt to provide entrants a stepping stone to full facilities-based entry. Arguably, platform competition that could emerge in local service markets–with the alternatives platforms being the public switched network, the hybrid fibre-coaxial cable network, the mobile and fixed wireless networks, and the electric power grid–is the only means by which widespread, durable competition will survive.

5. STRATEGIC MODELING OF LOCAL COMPETITION

5.1. Causes and Consequences of Local Network Competition

5.1.1. Meaning of Competition

Before discussing the causes and consequences of local network competition, it is important to determine what is meant by competition. An increase in the number of firms serving a local service market, net of any exit, is usually interpreted as an increase in competition.[117] Of course, the larger the new entrants–measured by their initial scale or the depth of their financial pockets–the greater the competition they contribute to the industry.

Empirically, the life span of a typical entrant tends to be fleeting. Geroski (1992) finds that, as a group, entrants into a wide range of industries take considerable time to accumulate a rather small market share. So far, this generalisation has been supported by the experience in local service markets. With the passage of time, and with accumulated investment, an entrant graduates to become an incumbent; the speed and extent with which this occurs is important in these markets because each new wave of local service competitors may rely on the facilities of earlier generations to gain entry into local markets.

Apart from structural measures, competitiveness of these markets will vary with price and non-price rivalry among local service providers. Price rivalry becomes more aggressive, for instance, following the removal of regulatory restrictions on rates charged by local providers. Rivalry may also intensify when users treat products and services offered by these firms as closer substitutes. This occurred when cellular telephony closed the quality and reliability gap with wireline alternatives, and the two technologies were drawn into head to head competition.[118]

The level of competition might also derive from disparities in carriers' costs. When, through investment, a local provider succeeds in lowering its costs, it becomes more competitive vis-à-vis its rivals. Sometimes merely reducing the employment rolls brings about the reduction in costs. In an ironic turn, by laying off employees, incumbents seeking to be more competitive have, in turn, added to the pool of potential entrepreneurs they have fed start-ups.[119]

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[117] While exit reduces this number we should note that assets of bankrupt providers that can be sold to subsequent entrants, and used by them, can speed the build out required for successful entry.

[118] In another example, CAPs initially targeted markets that were under-served by ILECs using innovative technologies. In time they expanded their offerings to more traditional markets and standard technologies, and competition between CAPs and ILECs intensified generating benefits for users in the form of lower price and improved quality.

[119] Many of the most successful new entrants into telecommunications have been founded and managed by alumni of AT&T, including Qwest, Teligent and Global Crossing.

5.1.2. Causes for Local Competition

As evident from the above discussion, two key sources for local network competition are the presence of enabling technology and accommodating regulatory policy. In certain markets, the existence of unserved demands for local service was another inducement for competitive entry.

Restructuring of established carriers may cause local network competition. Often this may occur under legal pressure as when AT&T agreed to divest to avoid further antitrust action. That divestiture created seven local telephone companies where there had been just one, and also created a powerful potential entrant in the form of AT&T's long distance division. Other restructurings are voluntary; once again, AT&T provides an example. The company has begun to divest its various lines of business including its broadband cable telephony and wireless divisions.

The role of technology clearly caused the initial local telephone competition that occurred after Bell's patent. The invention set off a land rush among prospective licensees vying for the most lucrative urban markets. After an initial chapter of competition with Bell,[120] Western Union ceded local telephony (and local telegraphy) services to the Bell interests, preferring to focus on what it viewed to be more lucrative long distance markets.[121] Once the Bell patent expired, a second land rush broke out as independent telephone companies descended on markets served by Bell operating companies, as well as smaller markets and rural areas outside the Bell ambit. Scale diseconomies of early switching systems was one of the most significant limitation on the size of the region that local companies could profitably serve.[122]

Easily a more significant factor in creating competition in a network industry like local telephone service is the possibility that entrants can interconnect their network with incumbents and otherwise gain network services that allow them to reach scales that are needed to achieve viability. These rarely occur voluntarily but rather are the product of regulatory and legislative mandate.

Competition, driven by desire to control local phone traffic, as well as the need to control costs, led to the invention of the automatic switch. Strowger, an undertaker, who suspected that the local switchboard operator was routing calls of potential clients to her husband (also an undertaker), allegedly invented one of the first automatic telephone switches. By automating a labour-intensive activity, incumbents who adopted this technology became more competitive, and the potential for over builders evaporated. In comparison, innovation aided new entrants when CAPs built network control centres to

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[120] Bell's telephone was capable of providing telegraph services as well as voice telephony. Even while Western Union concluded that local telegraphy was not worth the trouble, Bell's invention represented an early example of infrastructure convergence that brought new and established firms into competition with one another.

[121] Friedlander (1995, p. 29). At that time telegraphy had less severe distance attenuation problems than telephony. But with advances in copper wiring and the invention of the loading coil, long distance telephony would supplant Western Union's principally interurban network of iron and steel wiring which suffered from special limitations of its own. See Fagen (1975, pp. 200-209). In the largest urban areas, the telegraph network had a counterpart to the local exchange in the form of a system of pneumatic tubes that delivered paper messages to telegraph offices. See Standage (1998).

[122] Scale economies were also limited by the fact that early telephone systems were powered by batteries at both the customer premise and the central switchboard, a problem that was solved by the 'common battery switchboard' that centralised the powering of the network.

monitor and repair their networks from a central location with minimal need for field workers.

These examples show that innovations have indeterminate impacts on competition. In some cases they enhance scale economies and the cost advantage of embedded networks, augmenting the dominance possessed by an incumbent. In other cases they facilitate entry at small scale with low capital outlays and/or a highly differentiated service. Whereas the innovations may lower overall cost, MES could rise or fall, and affect concentration accordingly. A by-product of fast paced innovation is rapid obsolescence. Consequently, the advantage of the current incumbent is limited by the next generation of equipment that replaces it within a short span of time.

Standardisation of technical specifications can not only realise significant scale economies in production of the hardware and software needed to build the local network, but it can greatly ease the burden on entrants. A communications platform built on publicly available interfaces stimulates competition around the edges of the network as specialised firms are able to deliver products and services that inter-operate with the public local network.

Digital convergence that occurs when signals of all kinds can be carried on the same infrastructure medium holds the promise of expanded competition in local network markets. Exploiting the digitalisation of switching and transmission, local telephone companies can invade cable's video delivery market, cable systems can provide two-way voice services, and ISPs can use packet switched technology to carry voice conversations over the Internet. In the case of cable telephony, the incremental cost reduces to retrofitting the system to handle two-way digital signals and the installation of switching equipment. To be balanced, given that these networks were initially optimised for a specific service (e.g., one-way delivery of analogue multi-channel video), some compromise must be accepted relative to greenfield construction of a specialised network. At an operational level, its technicians must gain expertise necessary to accommodate a wider range of services on the networks they maintain.

Regulation can induce entry by creating cross subsidies in local rate structures. The lucrative markets beckon new competitors who pray the high margins will last long enough for them to recoup their investment, or to move into other markets. Such pricing could induce inefficient firms to enter the market, but if there are plenty of potential entrants, the more efficient ones should win out.

Asymmetric regulation can also facilitate entry competition with established carriers. This occurs, for example, when rules applied to incumbents are more restrictive than those for younger or smaller firms. Entrants may simply be relieved of the burden of filing and justifying their rates or their investment plans. A wider wedge is driven between incumbents barred from entering certain lines of business and entrants who enjoy much greater freedom, with the belief that, only when protected from competition, will new firms enter and thrive. In particular an incumbent is deprived of bundling an extensive range of services that might otherwise allow it to retain its local service customers.

As discussed in the previous section, TA96 obliges incumbents to supply entrants with network services with the goal of promoting competition. Pricing of these carrier services is crucial to the success of this approach to competition and has been the locus of intense legal and regulatory confrontation. Deregulation of rates and entry is a more pro-active means toward competition. Besides eliminating artificial barriers that block entry by efficient

competitors, the TA96 raised maximum foreign ownership percentage with the intention of expanding the pool of competitors.

Relaxing rate regulation can also intensify price competition, as when cost-based rate regulation of incumbents is replaced by incentive schemes. The expanded freedom tends to eliminate any price umbrella that may shield emerging firms from the full effect of competition. Over the longer run, this freedom can have a depressing effect on competition as judged by the ranks of new entrants. An example is Telecom New Zealand which, while its markets were opened to competition, was given almost complete pricing freedom (as well as minimal obligations to interconnect with competitors) to meet the competitive threats.

Privatisation of PTTs has been the first step toward local competition in many countries outside the U.S. Exposed to the forces of the financial markets, the restructured national carriers have turned in a remarkable record of cost cutting and quality improvement.[123] In other cases, however, local markets were opened to competition prior to privatisation. As signatories comply with the terms of the World Trade Organisation's (WTO) 'Basic Agreement on Telecommunications,' and as European countries adopt the EC's unbundling directive, these markets will witness continued pressure from competitive local companies.

Finally, demand conditions have also played a role in stimulating local competition. Especially outside the major industrial economies, user frustration with poor service quality and long waiting periods for connection has created profit opportunities for entrants able to persuade regulatory authorities they should enter. And even in major markets, certain niche services–typically cutting edge business services–provide openings for competitors, as when CAPs delivered highly reliable, dedicated services to customers who might otherwise have built a private network to obtain the desired service levels. In the data services area, the explosive growth in usage of the Internet and corporate intranets has driven demand for high-speed data access. Widespread diffusion of personal computers, as well as enterprise networks and web servers, fuels the data traffic, as do the growth of electronic commerce and other Internet applications.

5.1.3. Incumbent Responses to Competition

Incumbent responses to increased competition–though the record is far from complete–reveals a number of patterns. First, when able, incumbents cut rates for their services threatened by competitors. Second, they implement measures to improve their offerings; this might take the form of network modifications that increase capacity or reliability, or it might be more responsive customer service (order taking, billing, provisioning). Third, there is evidence that competitive pressures induce incumbents to cut their costs, usually by paring back their employment roles.[124]

Responses by U.S. local telephone companies to threats posed by competitive access providers illustrate several of these points. To begin with, the ILECs cut rates for the dedicated access services targeted by CAPs.[125] ILECs also devoted considerable effort to improving the reliability of their dedicated networks, and to shorten the provisioning time in line with CAP offering. While ILECs were early to deploy fibre ring networks, most of these

[123] Ros (1999).

[124] Ros (1999) for an empirical analysis at the country level. Gort and Sung (1999) look at long distance productivity using local services as the benchmark for comparison.

[125] Tomlinson (2000).

replaced interoffice transport facilities. They played catch up with the CAPs in terms of rolling out SONET rings in response to CAP competition.[126]

One last incumbent response bears mentioning although it is a political reaction to competition. Faced with competition, incumbents have appealed to regulators and solicited the courts to relax restrictions on their responses and to ease their obligations to assist new entrants. Incumbents do not have a monopoly on this political manoeuvre, however. Entrants have gone before regulators as well seeking protection from subsequent entrants once they succeeded in establishing themselves in the market.[127]

5.2. Strategic Choices of Local Network Entrants

Competitors in local service markets have various options for providing service. Two broad categories of strategies are facilities-based and service-based entry.

5.2.1. Facilities-Based Entry

At one extreme a firm may provide services over facilities that it owns. Invariably, these facilities are interconnected with other local networks with whom they exchange traffic, as well as with long distance networks–though dual systems of the nineteenth century demonstrated that it is possible for two separate local networks to vie for the same customers. Another more recent illustration is the presence of 'bypassers' that connect business customers to their long distance providers using microwave or fibre optic equipment without ever travelling over local network facilities.

A *de novo* entrant may be a start-up or it might be a firm established in another market that is diversifying into the provision of local services. Fixed wireless provides an example of technology supporting new entry into local access services. The latter may be market extensions (when a cable TV operator gets into the provision of voice telephony). In this way, long distance carriers have entered local markets recently in the apparent hopes of leveraging their existing facilities and telephony expertise.

Alternatively, the foray of an existing firm into an adjacent market constitutes a geographic extension; this occurs when in those rare instances a local exchange carrier attempts to provide service in another ILEC's franchise area. Alternatively, the firm may acquire an established firm or purchase its capital equipment. Certainly buying out an established domestic carrier is a rapid and apparently less costly means for a foreign carrier to enter a domestic market. In the US., in an attempt to enter local services markets, first the largest cable operators purchased the major CAPs, and then more recently the major long distance companies bought them out.[128]

Existing networks, designed for altogether different purposes, can be reconfigured to carry traffic in direct competition with incumbent local networks. Cable telephony offers a good example. Electric power companies not only use their internal fibre networks for local transmission services, they have also begun to deploy 'powerline' technology that delivers

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[126] See Woroch (1995) and Tomlinson (1995).

[127] As an example, in 1989, Teleport Communications asked the Massachusetts Public Utilities Commission to deny MFS certification in Boston. See Tomlinson (2000, pp. 189-190).

[128] See Woroch (1996) for an evaluation of the relative merits of acquisition strategies for entering the local exchange.

switched voice and data services directly to the home over the electric grid.[129] The incremental cost of adding local access service over these infrastructures may be quite low, and yet their coverage is nearly ubiquitous, and they have in place many existing customer relationships and brand recognition.

5.2.2. Service-Based Entry

Alternatively, an entrant may rely on the services of the incumbent local network, choosing to own almost no network facilities of its own. Such a service-based entrant not only gains access to essential rights of way and infrastructure, it also may lease wholesale services such as transmission capacity from local electric, gas or water distribution utilities.

The TA96 greatly expanded service-based options to include the purchase UNEs and the resale of retail services of the incumbent, and in some cases, joint occupancy of its facilities as well (e.g., sharing frequencies on the local loop). In implementing the Act, the FCC has defined seven network elements and proposed that the ILEC be obliged to combine them into platforms upon request.[130] If resale is the chosen option, any service the ILEC offers at retail must be available to the CLEC at wholesale rates.

Competitors may choose a mix of different facilities-based and service-based strategies—an option provided them by the TA96. Indeed, one principal motivation for UNEs is to encourage entrants to combine them with facilities that they build or acquire. Different methods may be used in the different regions, where a new carrier can purchase network elements in those markets where it is (and may always be) uneconomical to build a second network. Resale, in particular, may allow an embryonic carrier to quickly achieve a broad footprint as it builds out its network. In these ways UNEs and resale can function as an interim stepping stone to facilities-based entry.

Entrants commonly undercut the prices of incumbent carriers, at least when they first appear in the market. This is a necessity when its services are not greatly differentiated from the incumbent's. For this very reason, entrants usually strive to distinguish their offerings from what is currently available. Some variation is achieved by differences in structure of pricing of local services. During earlier episodes of competition, local franchisees were likely to use measured service while entrants quite effectively penetrated the market with flat rate prices.[131] In addition, since it seems that one-time connection charges loom large as a deterrent to switching to a new service, entrants have often held those down, usually amortising them over time or collecting them on other services.

5.2.3. Evaluating Entry Strategies

Comparing the two broad strategies for entering local network markets, both have their advantages. Facilities-based entry is very costly and, because of the sunkness of the

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[129] Another surprise comes from below ground where robots are used to string optical fibre through city sewer and water systems. See John Schwartz, "Wiring the City: Humans Won't Do," New York Times, March 8, 2001, p. D1.

[130] The Court of Appeals for the Eighth District upheld the FCC's designation of UNEs. That court also concluded that the FCC exceeded its authority when requiring that the ILEC provide a UNE platform, but the U.S. Supreme Court subsequently overturned this ruling.

[131] Gabel and Nix (1993).

investment, it comes with a high level of risk. On the other hand, entry of this sort poses much more potent competition than the service-based alternatives. When they design, build and own their own facilities, competitors have much greater control of operating costs and definition of services.

Entry by leasing incumbent facilities and reselling incumbent services, in comparison, requires much less upfront outlays, and if those wholesale services are available, can aid the entrant in getting to market more quickly. A service-based entrant, however, has costs that are highly dependent on incumbent pricing of the requisite services and, equally important, the incumbent's design of the features of those services and where and when they are available. In the end, a service-based entrant forfeits considerable control over what it can offer its customers.

In choosing which route to follow, both the existing structure of local service markets as well as its inherent assets enter into a potential entrant's decision. The incremental cost of building a new network is important for the facilities-based alternative, along with the difficulty of integrating it with existing infrastructure.[132]

Whether they enter *de novo* or diversify from other markets, and whether they build their own facilities or purchase network services from an incumbent, the more successful entrants into local services follow an evolutionary approach. Typically, they establish a toehold in some services, sold to certain customer segments in some geographic area before venturing into other markets. In the beginning CAPs entered as "carriers' carriers" by hauling long distance traffic among interexchange carriers in the largest urban areas. After initial success, they began to offer dedicated services to large businesses and government agencies. It would take time before CAPs as a group would begin to serve mid-size and smaller businesses in second and third tier cities, and to provide switched local services to its customers including residential users. Today, CAPs serve a wide range of markets with the fastest growing being in Internet services such as web hosting and caching.

5.3. Strategic Models of Local Network Competition

A logical approach to modelling local network competition, given the small number of competitors, is to use game theory methods. This formulation would include at least two types of players, incumbents and entrants. In a simple version, a single incumbent faces a single potential entrant in each period. Strategies include the decision of where to build a network and what capacity it should have, which services to offer and their prices, and whether to interconnect with other networks and how much to charge to terminate traffic. Features of local network competition that we have discussed elsewhere that are less easily incorporated into these models include the presence of network externalities and the sunkness of network investment.

5.3.1. Co-operative Game Approach

In this approach to network competition, a player is synonymous with a traffic flow that travels along various paths connecting two nodes. The question is whether, for some

[132] For an analysis of the different options facing cable operators seeking entry into telephony, see Woroch (1997).

allocation of the surplus generated by the network, every coalition of players (traffic flows) can be discouraged from breaking away and serving themselves alone using a standalone network. Usually, for reasons of scale and scope economies, it is assumed that the grand coalition can generate the greatest aggregate surplus for the players taken together. This condition alone is insufficient to prevent a subset of players from defecting. Hence, in the words of co-operative game theory, we seek a 'core' of the network game.

Sharkey (1991; 1995) has made significant contributions to answering this question and identified operations research literatures that address similar questions. In the end the message is not entirely optimistic. Fairly plausible conditions characterising local network environments fail to imply a core. Sharkey finds conditions such that there is nearly a core of the co-operative game. Bittlingmayer (1990) and Woroch (1990) find conditions when the core fails to exist in much simpler network structures.

5.3.2. Non-co-operative Approaches

An alternative formulation makes explicit the selection of strategies chosen by individual competitors. In this non-co-operative approach firms choose prices, qualities, and investment and also negotiate the terms of inter-carrier transactions. Compared with the co-operative approach, non-co-operative models have the potential to predict levels of these variables in equilibrium. They suffer from some of the same infirmities as solutions to co-operative problems: multiple equilibria or no equilibrium at all.

An early example of the non-co-operative approach to local network competition, Economides and Woroch (1992), treated the case of the network access problem. This paper started from the 'rat-tail structure' described by Baumol (1983) where an entrant seeks to gain access to use of an incumbent's bottleneck facilities. Final and intermediate service prices are chosen non-co-operatively. They find that, among other results, equilibrium foreclosure of a non-integrated entrant depends on the extent to which the retail products of the two carriers are differentiated.

A different problem arises when two carriers initially compete for customers on equal terms and seek to interconnect to exchange two-way traffic. A typical approach to model competition for customers is to place them on a 'Hotelling' line with networks at endpoints.[133] The spatial differentiation now takes the form of an inherent preference by users for one network over the other. Demand for calls with all other users is assumed to be 'isotropic,' meaning they derive the same value from a call regardless of who they connect to. In Economides, Lopomo and Woroch (1996a; 1996b), an incumbent network is distinguished by its ability to commit to pricing of retail and wholesale service prior to the arrival of the entrant. This assumption leads to the conclusion that the incumbent can structure originating and terminating prices so as to foreclose entrants from the market.

One other non-co-operative approach to local network competition treats the ILEC as a dominant firm and CLECs as fringe firms.[134] Here again the incumbent enjoys a strategic advantage in terms of its commitment to prices, while competitors take these prices as given.

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[133] Papers that adopt this modelling approach include Armstrong (1998b), Laffont, Rey and Tirole (1998a;1998b) and Economides, Lopomo and Woroch (1996a; 1996b).

[134] Examples of this approach include Abel (1999) and Plott and Wilkie (1995).

5.4. Entry Barriers

At various times in the above discussion, we pointed out different sources of barriers to entry into local exchange competition. Several of these barriers were natural, as with the strong scale and scope economies inherent in production of network services, and the huge sunk investments that are necessary for facilities-based supply. Other barriers are artificial when they are erected by regulations or legislation, as with the licensing and certification of competitive local carriers. Demand-created barriers are also prominent in the local services business as they are in many network industries. Positive feedback effects and user switching costs steer consumers away from new, small entrants. In fact, a principal concern of this section is the extent to which incumbents can strategically leverage these natural advantages to deter efficient entry into local network markets.

5.4.1. Natural Barriers

In the cost section, we surveyed some of the econometric evidence on the presence of scale and scope economies in this industry. While this literature is inconclusive, it is reasonable that–for a sufficiently limited area such as a sparsely-populated residential neighbourhood–natural monopoly conditions prevail. Duplication of facilities is not the only way to inject competition into these markets, however. Entrants could simply share the use of existing facilities.

Scope economies can be an effective means to extinguish embryonic competition, provided they are supplemented with bundling strategies. Due to the costs and time involved in starting out, a local competitor cannot roll out the complete line of services from the beginning. An incumbent can defeat selective entry by bundling the service threatened by competitors with its protected services. Absent alternatives for these monopolised services, customers will prefer to buy from the incumbent as its marginal prices for the potentially competitive services are effectively zero.

5.4.2. Artificial Barriers

Government intervention into local services markets is often responsible for barriers that competitors face. Many of these barriers are justified on efficiency grounds as in the case of patents and other intellectual property protection. The efficiency rationale for other restrictions on entry, such as licensing and certification of local competitors, are less apparent.

Access to certain essential resources is crucial to successful entry into local exchange markets, and some of these are controlled by government authorities. Wireline (and wireless) networks need access to rights of way, conduits, ducts, poles, and easements. Wireless networks need to locate their antennae, and more importantly, usually need rights to radio spectrum. Both carriers require telephone numbers if they wish to provide access service to end-users. The availability of this scarce resource is determined by property rights, and if phone numbers are allocated on a first-come basis, incumbents will have an advantage having claimed them over time. On the other hand, burdens are imposed on incumbents that entrants escape entirely, such as carrier-of-last-resort requirements and universal service obligations.

5.4.3. Strategic Entry Barriers

Strategic barriers are market conditions created by incumbent carriers that make entry more costly for prospective competitors, and that would not exist but for the threat of entry.

One of the best known means to erect a barrier is to make irreversible investments in durable assets.[135] Investment of this sort is unavoidable for wireline networks as physical transmission paths tend to involve facilities that are very costly to redeploy. Compare that to a wireless network where the transmission path is the airwaves. In that case it is more a matter of whether expenditures to acquire rights to those airwaves are sunk, or whether the licenses are easily transferable at the market price. As a consequence of its sunk investment, an ILEC becomes a formidable competitor, willing to cut prices to a much lower level in the event of a price war with a competitor provided, of course, that the investment is observable by potential entrants. In a world of fast paced innovation, the advantage conferred by such investment is transitory, however. With each new generation of equipment, the incumbency advantage is at least partially neutralised.

Some embodiments of a first mover advantage are much less tangible than investment in switches and cables. By virtue of its history of serving the market, an incumbent has established a reputation with local customers whereas an entrant might be unknown, and hence, risky in the eyes of consumers.[136] One reason that cable, long distance and electric utility companies have an advantage over *de novo* entrants into local exchange markets is their recognisable brand names and existing commercial relationships with potential customers in an area.

Loyalty to the incumbent may not derive just from the expectation of good service in the future. It may be caused by the switching costs anticipated by users should they choose to switch to a new supplier. It results in a reluctance of customers to switch to a new carrier even when it offers better price-quality package. As one example, upon switching to a new carrier, a user would have to choose a new phone number (if number portability was not required). Users would then have to notify all associates of the change, reprint new stationery and business cards, and so on. Even without these explicit costs, users display inertia in responding to alternative suppliers.[137]

In other markets, incumbents have been known to enhance the loyalty their customers exhibit by signing them onto long-term contracts that discourage them from switching to another supplier. Note that long term contracts and relationships with customers, especially large business customers, can cut the other direction as well: these contracts and relationships can limit the incumbent's range of actions, and render it more vulnerable to competitors.[138] In particular, to be technically compatible with its major customers, an ILEC may be reluctant to upgrade its network with the latest carrier equipment and technology.

An ILEC may sell services at volume discounts that are sufficiently large to make it unprofitable for an entrant to match assuming it cannot yet achieve efficient long run scale.

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[135] Dixit (1979).

[136] An entrant could also be disadvantaged if it draws an unattractive sample of customers. This might occur if subscribers with bad payment records are diverted to new entrants. Customers who switch away from the incumbent may also be more likely to switch back adding to an entrant's high customer acquisition costs.

[137] See Knittel (1997) in the case of long distance service.

[138] See Christensen (1997) for a detailed discussion of how this occurs in the hard disk drive industry.

More explicit is the 'market share discount' in which unit price falls as the percentage of service bought from the incumbent increases.[139] A multi-product firm also has the option of product bundling that can increase the sources of switching costs for a local service customer.

Another incumbent advantage stems from demand-side scale economies. Users place greater value on subscribing to a carrier's service the larger its customer base. Such network externalities encourage users to join the largest of the available networks, all else equal, and this in turn will tend to make the large network grow even larger relative to its competitors. This logic depends on the absence of interconnection among competing networks, for otherwise subscription to any one network would give a user access to all other users.[140] Interconnection neutralises any first mover advantage an incumbent might posses as a result of its larger customer base, provided that it does not re-create a pecuniary equivalent of network externalities by pricing traffic among its subscribes differently than traffic that travels between networks. In that case, once again a user will prefer the larger network to take advantage of the lower on-network rates.[141]

An opportunity for strategic behaviour that is very ripe arises when ILECs are obliged to supply entrants with network services such as interconnection, collocation and unbundled network elements. By pricing these carrier services above cost, effectively selling the same services to its downstream affiliate at cost, the incumbent executes a 'price squeeze.' Similarly, in choosing the quality of these services, the incumbent can choke off a threat to its markets by supplying substandard access service to the entrant. Different models have come to different conclusions as to whether these exclusionary actions could be part of an equilibrium,[142] and empirical evidence does not settle the issue. In a closely related wireless context, Reiffen, Schumann and Ward (2000) fail to find conclusive evidence that the local wireline carrier favours its affiliate over the non-wireline competition in U.S. cellular markets relative to the alternative hypothesis of efficiencies between the two operations.

To sum up, technological economies–either cost sub-additivity or scope economies–are effective in achieving and maintaining dominance in the local service supply. They are neither necessary nor sufficient, however, for single firm to prevail in an unregulated market. An early provider of local services can leverage properties of that market–such as long-term contracts, brand recognition, network externalities, and user switching costs–to solidify its market position. Incumbents have natural disadvantages in competing in local service markets as well. For instance, over time, they are likely to become more heavily unionised, pay higher wage rates and have more restrictive work rules than a firm new to the market. How the balance of advantages and disadvantages among incumbents and entrants plays out depends in large part on regulatory policies that attempt to equalise conditions between the two firms.

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[139] A variant is the 'loyalty discount' whereby customers receive a rebate when they buy all of their services from the same provider.

[140] Residential subscribers sought to join the largest local network during the era of dual local systems, although businesses were compelled to subscribe to all services. Neither of these would be a concern if the networks were interconnected, both with one another and with all long distance networks.

[141] MCI innovated this kind of pricing policy with its "Friends and Family" program.

[142] Economides (1998) finds that the quality squeeze will occur while Sibley and Weisman (1998) come to the opposite conclusion.

6. EMPIRICAL EVIDENCE ON LOCAL NETWORK COMPETITION

As a product of the short history of local competition, empirical research into its causes and consequences is sparse and idiosyncratic. What exists can be partitioned into investigations of the various determinants of competitive entry and the measurements of the economic effects of competition.

Many studies have examined effects of opening local exchange to competition at the country level.[143] The high level of aggregation does not permit tests of hypotheses of microeconomic effects, much less the nature of the strategic interaction among firms. For this reason, the research surveyed below is distinguished by being market and firm level.

We begin with empirical models that attempt to explain the incidence of local competition, and in some cases its timing as well. Woroch (1992) estimated a probit model of incidence of facilities-based CAP entry into the 120 largest U.S. cities using a using an original panel dataset that recorded deployment of fibre ring networks over the post-Divestiture period 1984-1991. As might be expected, population density of market and favourable state treatment of bypass are strong attracters for CAPs whereas ILEC fibre investment tends to discourage entry.

Zolnierek, Eisner and Burton (2001) examine the incidence and extent of local exchange entry following passage of TA96. Measuring entry by the number of carriers issued number code blocks in each of 190 LATAs, they estimate a multinomial logit model of entry as a function of LATA characteristics in each of four years, 1996-1999. The results confirm that highly populated and urbanised LATAs are the likely targets of most competition, as are areas served by one of the RBOCs.

Turning to empirical studies of competitive effects of local competition, Hausman, Tardiff and Ware (1989) was an early investigation study of the impact of local competition for business services. They measured changes in business use of long distance access services caused by entry of Teleport, Inc., Manhattan Cable, and others into the New York City market. They found that connection to alternative carriers reduced usage of switched long distance services by New York Telephone's large business customers significantly.

Another early study does not directly examine local entry effects, but is close enough to deserve attention. Mathios and Rogers (1988) examined state allowance of entry into the intraLATA toll market. They found that a state ban on facilities-based entry and resellers increased the average price of an intraLATA toll call.

A more recent contribution to this literature, one that uses the same entry measure as Zolnierik, Eisner and Burton (2001) is by Koski and Majumdar (2000). They examine strategic responses of U.S. ILECs to contemporaneous competition (measured by the number of firms with numbering resources) over a five-year period before and after the TA96. Using a panel over firms and years, they do not uncover a relationship between incumbent access pricing and entry.[144] However, Koski and Majumdar do find that ILECs raise advertising and become more focused on core telephony operations in response to competitive entry.

In evaluating all of these studies, extra caution should be exercised when interpreting

[143] See Ros (1999) and Walsten (2001).

[144] Similarly, looking at rate levels charged by ILECs for DS3 special access services, Woroch (1992) fails to find a statistical dependence on the incidence of CAP entry.

their results to convey the cause-effect relationships governing competitive entry. To begin with, incumbent actions may not be clearly strategic in nature. Deployment of advanced network infrastructure as a cost reducing action could be confounded with an attempt to deter further entry. Even entrants' intentions may not be apparent. Certification by state commission, leasing rights of way, acquisition of numbering resources, and even construction of local networks do not necessarily represent true competition. Actual competition occurs only when the competitor begins to deliver services. Many instances exist where carriers merely acquire an option on future entry, or possibly pull out after an initial foray into a market.

To better expose the relationship between actions of incumbents and entrants, it is necessary to take full advantage of the inter-temporal dimension of the panel datasets. Toivanen and Waterson (2000) provide an example of this approach in a completely different industry. A similar approach was applied in Woroch (2000) to local exchange competition. That paper models ILEC and CLEC deployment of urban fibre rings in the U.S. over 1984-1992. Allowing for different lagged relationships, it is found that incumbents and entrants tend to match each other's deployments: entry triggers ILEC investment, and ILEC investment tends to invite competition.

7. WIRELESS LOCAL COMPETITION

This section examines the extent of current competition offered by various wireless technologies and the near-term prospects for this competition. Wireless service comes in two varieties: fixed and mobile. Fixed wireless is provided by a dedicated radio path linking a customer to the network facilities. Mobile wireless also establishes a radio link but here the customer can be anywhere in the serving territory, including travelling at fairly high ground speeds.

The origins of wireless communications technology was as a means to improve the delivery of safety and emergency services and to facilitate communication on the battlefield. Commercial application of these technologies has achieved staggering success world-wide, as is clear from data on penetration and usage of these services. The ITU estimates approximately 720 million wireless lines world-wide as of the end of 2000 compared to 992 million main lines, and expressed in terms of population, there were 11.89 mobile lines per 100 population compared to 16.32 landlines.[145] Despite the lead of fixed line, the gap with wireless is closing rapidly: year on year growth in subscribers over the five-year period 1995-2000 was about 50 percent for mobile wireless but only 7 percent for fixed line. For this reason, the ITU projects equality for the two types of lines by about 2003. The popularity of fixed wireless has been much less impressive than mobile wireless. Only in developing countries has fixed wireless penetrated the residential sector to any extent.[146]

Our concern, however, is not with the success of wireless technologies to achieve high penetration levels, or even with competition among wireless providers, but rather whether wireless technology industry constrains the pricing of incumbent (and entrant) wireline local service carriers. Does wireless service constitute a sufficiently close substitute to local

[145] ITU Telecommunications Indicators (2001).

[146] CTIA (1999) estimates that there were upwards of 2.7 million wireless local loops in the U.S. about mid-1999.

wireline such that residential and business customers choose to use their wireless phones more often than their stationary phones, or even to replace their wireline phones with wireless alternatives? Are wireless providers capable of, and likely to, offer their services at reasonable prices over a wide area and with sufficient capacity to handle all voice and data traffic that currently travels on the PSTN?

Before turning to these questions, I give a brief, non-technical description of the wireless technologies with special attention to how they compare with the wireline alternatives, and then summarise the state of competition in the wireless sub-markets.[147]

7.1. Wireless Communications Technologies

7.1.1. Mobile Wireless Service

The first mobile wireless technology–Advanced Mobile Phone Service (AMPS)–was developed at Bell Laboratories in 1947. This system made an analogue radio connection between a transmitter tower and a user's handset. Frequencies were reused by partitioning a region into cells with a base station near the centre of each cell. The technology provided for "hand off" of a call as the user passed from one cell to another, even at highway speeds. The earliest commercial cellular phones were bolted into automobiles, and some time passed before transportables were introduced or today's miniature handsets appeared.

The first commercial cellular mobile service was launched by NTT in Tokyo in 1979. It was not until 1981 that the FCC decided to structure the U.S. cellular industry as a duopoly by creating two franchisees for each of 306 metropolitan areas and 428 rural areas. One license went to the local wireline incumbent serving each area while a second was awarded to a non-wireline independent carrier.

Cellular debuted in the U.S. when Illinois Bell first offered service in Chicago in October 1983. The following year Washington, D.C. became the first metropolitan market to offer users the choice of two cellular providers. During these early days, cellular coverage was spotty in large part because franchisees had not yet built out their networks. Invariably the wireline franchisee was ahead in the race to build the initial cellular network. To prevent the wireline franchise from dominating a market, the FCC required it to resell cellular network services to the non-wireline franchisee while it was still building out its network.

The technical quality of early systems was not good by today's standards due to rudimentary transmission equipment and propagation problems of the AMPS system. In addition to the poor quality of service, cellular service was very expensive across the board: handset equipment cost, activation and monthly subscription fees, and airtime charges. For these reasons it is little wonder users did not view cellular as a substitute for wireline service for many years to come.

Today, besides analogue cellular service, digital cellular is the leading technology with Personal Communications Services (PCS) widespread in the U.S. and Groupe Speciale Mobile (GSM) the standard throughout the rest of the world. [148] Paging services are also

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[147] For more details see the Hausman chapter in this *Handbook*.

[148] There were other analogue cellular standards besides AMPS that were used in various countries including Total Access Communications System (TACS) in Europe, the Nordic Telephone System (NTS) in Scandinavian countries, C-450 in Germany, NTT and JTACS in Japan and Radio Telephone Mobile System (RTMS) in Italy. See National Research Council (1997, Table 1-3).

commonplace with two-way paging now beginning to appear in significant numbers. Less common mobile wireless technologies include Enhanced Mobile Radio Services (EMRS) such as the service offered by Nextel and satellite mobile phone systems such as the one Globalstar is deploying.

Modern mobile wireless technologies have made huge strides, both in terms of the technical quality of voice transmission and expanded vertical features. The second generation of mobile wireless was digital. Besides improved clarity, digital transmission greatly increased the carrying capacity of the congested frequency bands allocated to these services. Digitalisation allowed for coding of signals to prevent eavesdropping, a risk that remains a serious drawback for any analogue service. The Code Division Multiplexing Access (CDMA) protocol, originally developed for secure battlefield communication, makes signals virtually unbreakable. The new digital standards also added many vertical features that were bundled with voice telephony: paging, custom-calling features, voice mail, and now two-way email and web browsing.

The third generation (3G) wireless–sometimes called Universal Mobile Telephone Service (UMTS)–promises to greatly expand the bandwidth. Whereas current analogue and digital cellular services have a top data rate of 14.4 kbps (with 9.6 kbps being more common), 3G promises speeds of 2 Mbps.[149] This advance will enable Internet services over mobile phones comparable to those possible over a high-speed copper local loop and hybrid fibre-coaxial cable–with the added benefit of mobility.

Significantly, the newer digital technologies adopted smaller cell sizes which require reduced power levels.[150] This, in turn, reduced power requirements of handsets, making possible smaller batteries and longer talk times. Scale economies and the steady advances in design of digital signal processing (DSP) chips continue to drive down the costs of handsets and transmitter equipment. The smaller cells also made handoff more frequent, increasing the software and processing necessary to maintain service at highway speeds. The result was greater capital outlays required to build and interconnect the cell sites, raising the cost of deploying micro-cellular technology in sparely populated regions.

7.1.2. Fixed Wireless Service

This radio transmission technology replaces the copper loop, a coaxial drop or fibre drop with a high-frequency radio link, and for this reason is often called a wireless local loop (WLL). Economically, a radio link becomes more economical relative to these wireline alternatives the greater the distance between the user and the network switch. For this reason, it is not surprising that a very early fixed wireless service, BETRS (basic exchange telephone radio service), was deployed by local carriers to reach remote residential customers mainly living in rural areas.[151] More recently, higher frequencies have been developed to provide high-capacity point-to-point and point-to-multi-point connections. Multi-point multi-channel distribution system (MMDS) operates in the 24 GHz band. WinStar is an advocate of this

[149] FCC, Fifth Report on Wireless Competition, Aug. 2000, p. 36, fn. 237. Note that 3G speeds drop to 144 kbps when the user is travelling at highway speeds.

[150] I will not discuss the specialised wireless networks such as wireless PBXs installed in buildings and campus-wide wireless LANs.

[151] United Utilities in Alaska has offered BETRS as a customer option as opposed to the carrier making the choice as a wireless last mile technology.

technology as are several long distance companies seeking a wireless entry into local markets.[152] A second technology, Local Multi-point Distribution System (LMDS), is located in the higher 38 GHz ranges and, because of its enormous carrying capacity, is often referred to as "wireless fibre." By and large, both MMDS and LMDS technologies require line of sight to be most effective, and are vulnerable to rain fade and interference from foliage.

Fixed wireless technologies such as MMDS and LMDS are often referred to as 'big stick' technologies because they deploy a single tall antenna to serve each local area. They are especially well suited to high volume, data intensive business customers–especially those located in edge cities too far to justify building a dedicated fibre spur off an urban ring. The high frequencies allow transmission of huge amounts of voice and data to an interexchange carrier, an Internet backbone, or the company's local branch offices. In this respect, providers compete head to head with ILEC business services and with CAPs.

7.2. Wireless Services as Wireline Competitors

Whether wireless providers can and will constrain the behaviour of local wireline carriers requires a comparison of supply and demand conditions of the two services. While fixed wireless will be discussed, the focus will be on the competitive threat posed by mobile wireless .

On the supply side, wireless networks are quicker to build and less costly to maintain, the principal reason being that a large portion of the transmission path is just airwaves. Once a carrier has a license to use the spectrum in the area, no additional investment is necessary beyond the transmitter and receiver equipment at the ends of the communication link. On the other hand, the airwaves can be hostile toward electromagnetic transmission. Adverse climate and terrain, idiosyncratic propagation properties, and radio wave interference all tend to reduce the overall reliability of wireless networks relative to wireline systems.

Wireless nonetheless has some features that make it part of an attractive entry strategy for a competitive local exchange company. Compared to wireline build out, a wireless network has a negligible marginal cost per line which does not vary with distance to the user.[153] For this reason, wireless has a particular advantage over wireline in serving sparsely populated areas. Another feature of wireless technology is that its infrastructure tends to be modular so that the network provider can incrementally add capacity as demand for its service grows.[154] This is important, for example, to an entrant who will inevitably share the local market with the wireline incumbent for many years to come.

On the other hand, radio spectrum can be a source of diseconomies when it is partitioned among several carriers. When, for instance, a block of spectrum is equally divided between two carriers, the amount of idle spectrum will necessarily rise. The reason lies in the fact that there will be times when one carrier has reached its spectrum limit, but not the other.

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[152] In the U.S., these bands were earlier used to distribute multichannel video, a service that was dubbed "wireless cable."

[153] Much of wireless expense is fixed relative to number of subscribers and their usage. So while it has a very small marginal cost quite independent of population density (though dependent on population mobility), it may have a high average cost which is sensitive to density.

[154] As an example, a cellular mobile network can partition its cell sites and use directional antennae to squeeze more capacity out of the same frequency band should the need arise. For more detail on this strategy, see the chapter by Hausman in this *Handbook*.

In absence of a means to share spectrum across carriers on a spot basis, less service will be provided than if a single unified wireless carrier utilised this bandwidth.

Wireless technologies of all kinds face several entry barriers not all of which are technological. First and foremost, licenses to use the airwaves are essential to any wireless venture. When those frequencies are not already occupied by a current tenant, and when these rights are auctioned to the highest bidder, the winning bids may extract much of the profit available from the service. The spectrum may also come with use restrictions which limit its usefulness to the carrier. It was only recently, for example, that the FCC permitted two-way transmission by LMDS license holders. Another, more tangible essential resource required by wireless providers are rights to locate their transmitter towers and related facilities. Wireless carriers can meet stiff resistance from communities seeking to preserve an aesthetic skyline or simply to exploit a potential revenue opportunity. The economics of wireless technologies, however, results in significantly lower entry barriers than their fixed line cousins.

On the demand side, we are especially interested in the extent to which users are willing to substitute a wireless alternative for their wireline service. More precisely, if the price of local wireline service were to increase by a significant amount, would users switch over to wireless alternatives in large numbers, either by replacing their fixed line with a wireless phone, or by shifting usage to mobile phones? Effectively, we are interested in the "diversion ratio" between wireline and wireless services: the percentage of the users who leave the PSTN who will turn to wireless in response to a wireline price hike. In conducting this thought experiment, we need to take account of initial wireless prices since wireless will not inhibit an increase in wireline prices if wireless is already very expensive. Also, if imperfect competition in wireless markets leads carriers to raise their prices in response, then little migration can be expected.

To assess whether wireless is a substitute for wireline, we begin by examining the properties of the two services. In several respects wireless and wireline provide the same local services: both provide access to the PSTN for incoming and outgoing calls; both offer a similar array of vertical features such as custom calling features and voice mail; both provide access to the Internet as well as to each others base of customers (assuming full interconnection).

Nevertheless each technology excels in certain areas. Wireline systems–whether the PSTN's copper loops or cable TV's coaxial cable–deliver much higher bandwidth with greater reliability using current technologies. Mobility is the key differentiating characteristic of wireless. Mobile wireless makes users 'accessible' so that they can receive calls at any time and in any place in the serving area. With fixed line service, one must be near the phone to receive calls, although voice messaging helps to fill the gap. In this direction, mobile wireless also satisfies demands for 'expediency' in that the users can place calls immediately rather than waiting until they reach a wireline phone, such as a public payphone. On the other hand, mobile wireless is a personal service with the phone carried by a single individual. In contrast, different members of a household can more easily share the wireline by virtue of occupying the same house.

It is also possible, in principle, that the two services are complementary, at least for some users. Intra-household communication will certainly be facilitated when both types of lines are available to household members. In that case household members can be reached as

they roam about the local area. Businesses may realise the same kind of benefits by connecting itinerant members of project teams.

In the end it is an empirical issue whether, on net, wireline and wireless services are substitutes or complements. While per-line usage of the PSTN in the U.S. has reached a plateau, growth of mobile wireless usage remains strong. Of course, these trends were greatly assisted by the relative price changes between wireline and wireless services. For instance between December 1997 and October 2000, it is reported that U.S. prices for cellular telephone service *fell* by 27.0 percent whereas the index for local charges *rose* by 9.8 percent.[155] Over the 10-year period ending in 1999, the number of cellular lines grew 2,359 percent while wireline subscriptions grew just 28.9 percent.[156]

Econometric modelling is needed to isolate the portion of these trends that is attributable to substitutability between the two services. Using a sample of U.S. households having at least one wireline phone, Ahmad, Ward and Woroch (2000) find preliminary evidence that households treat the two services as substitutes in terms of usage. Households may substitute mobile wireless for wireline for non-local calls. Indeed Ahmad, Ward and Woroch (2000) find higher wireless usage prices lead to higher wireline long distance usage.

A form of substitution that would have more sustained competitive effects would, of course, be replacement of wireline with wireless service. In fact in most countries, growth of wireless lines exceeds landline, and in some (e.g., Norway, Korea, Japan) wireless *total* lines exceeds landline total.[157] While there is anecdotal evidence that some households–typically a single young adult–are relying exclusively on wireless service, the numbers in the population are small. Sung, Kim and Lee (2000) observe that, in Korea, not only have wireless sales overtaken wireline, but users are also disconnecting their traditional phones.[158]

Another form of substitution occurs when new subscribers (usually a result of in-migration or new household formation) opt for wireless access rather than fixed service. The percentage of individuals who depend exclusively on mobile wireless service has been estimated to be 3 percent in the U.S.[159] and 6 percent in the U.K.[160] Alternatively, as a household's demand for communications increases, it may choose to meet that demand with mobile wireless. The FCC recently reported that survey results show that 12 percent of households chose mobile service rather fixed line when adding a second line.[161]

It is important to emphasise the role that pricing plays in determining demand for mobile wireless service and its substitution for wireline. Typically, mobile service is more costly than wireline, though that difference is shrinking. As of December 2000, the CTIA reports that the average cellular bill was $45.27 while the FCC estimates the typical local wireline bill to be $34 in that same year.[162] Of course, these figures must be compared understanding that the usage level of the typical line could be vastly different for the two

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[155] Bureau of Labor Statistics, Consumer Price Index Detailed Report, October 2000, Table 25. See also the chapter by Hausman in this *Handbook*.

[156] CTIA (2001) and FCC Trends in Telephone Service (2000).

[157] ITU (2001b) counts 35 countries as of mid-2001 in which mobile phones had overtaken fixed lines.

[158] In one study, it has been estimated that between 1990 and 1996, 60,000 landlines were displaced by wireless lines in Nordic countries (OECD, 1995). More recently, the ITU (2001b) notes that in the last ten years, household penetration of fixed line in Finland has dropped from 94 percent down to 83, during which time mobile has increase from 7 to 60 percent.

[159] FCC, Sixth Report of Wireless Competition (2001).

[160] OFTEL (2000b).

[161] FCC (2001), op.cit..

[162] FCC Trends (2000, Table 3.2).

services. For instance, since cellular and PCS services in the U.S. usually charge by the minute–whether incoming or outgoing–usage can be expected to be less for the same user. Until a calling-party pays (CPP) system is implemented, and until measured local service becomes prevalent, this pricing regime will exert a drag on wireless usage. Prepaid mobile service would counteract the effects of high relative usage prices for wireless. So far, however, prepaid service has not been as popular in the U.S. as it has elsewhere.

7.3. Structure of the Wireless Industry

Supply and demand substitutability between wireline and wireless services is a necessary condition for competition but alone it is not sufficient. Wireless services may, due to imperfect competition, be priced very high relative to wireline substitutes, discouraging users from making the switch. The first decade of the U.S. cellular industry illustrates this situation. Structured as a duopoly, with the FCC and the states forbearing from regulation, prices would not tend to fall as much as under unfettered competition.[163] The limited spectrum allocated to the service relative to the capabilities of the original AMPS technology contributed to the lack of competition. At the end of 2000, the HHI of the U.S. cellular and PCS industry was 1,564 measured on a nation-wide basis in terms of subscribers.[164] This represents a decrease from an HHI of 1,846 from one year earlier. Using data from the early 1990s, Parker and Röller (1997) find econometric evidence that, prior to the introduction of PCS, the cellular duopoly in the U.S. was imperfectly competitive, and trace it to multimarket contact and cross ownership among cellular providers. Ruiz (1994) and Fullerton (1998) reach more mixed conclusions when testing for various kinds of collusive behaviour.

Another reason why mobile wireless markets might not achieve competitive outcomes is ownership of one (or more) of the wireless carriers by the incumbent wireline company. A vertically integrated ILEC could execute a price squeeze on its wireless competitors by charging high rates to terminate their traffic on the wireline network. The ILEC could also subsidise its wireless operations by shifting costs to its wireline side assuming that business operates under cost-based regulation.

With the launch of PCS in 1996, the U.S. wireless industry was quickly transformed from an industry of isolated, geographic duopolies to one populated by several wireless oligopolists. Many of these new carriers had coast-to-coast footprints as a result of large mergers among wireless carriers and the availability of national PCS licenses. Today in the U.S. there are six nation-wide wireless carriers.[165]

Competition among mobile carriers drives down wireless prices, and raises service quality for the user, and in the process, wireless becomes a more attractive alternative to wireline service. Besides the advent of PCS, intra-wireless competition has intensified in recent years for several other reasons. New digital radio technologies have expanded the

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[163] See, however, the chapter by Hausman in this *Handbook*. Hausman maintains that a number of states regulated mobile service prices and that this regulation resulted in higher prices than in those states that had no price regulation.

[164] Computed from subscriber totals reported by the largest 25 mobile wireless providers in the FCC's Sixth Report on Wireless Competition (2001, Table 3, p. C-4). These data are on a national level; taking an average of HHIs computed for individual MSA and RSA markets likely will produce higher levels of concentration.

[165] AT&T, Sprint, Nextel, Verizon, VoiceStream, and a joint venture between BellSouth and SBC, Cingular Wireless.

array of possible wireless services. PCS in the U.S. and GSM elsewhere are examples. The FCC reports that, by the end of 2000, nearly 91 percent of the U.S. population had available three or more mobile wireless providers, and nearly 75 percent had five or more.[166]

Outside the U.S., privatisation of state-owned wireless carriers and the opening of existing wireless markets to entry by private carriers intensified competition in these markets.[167] In markets such as Europe, CPP and pre-pay systems and the prevalence of measured fixed service added to the growth of wireless service relative to wireline.

7.4. An Assessment of the Wireless Threat

We can expect that, in time, the threat posed by wireless will grow as competition among wireless providers further drives down wireless rates and as deregulation continues to rebalance local basic service charges.[168] Technological advances will continue to close the quality and bandwidth gaps between the two technologies. Relentless build out of wireless networks has enveloped ever-larger serving areas. In the very near future, wireless will overtake wireline in both access lines and usage in many of the major developed countries of the world.

Despite the pressure on price and quality, wireless is not likely to supplant the wireline network anytime soon. The PSTN offers considerable advantages. Foremost is the fact that the wireline network is already built and ubiquitous. On the data front, wireline is likely to maintain its lead as the two technologies will continue their cat-and-mouse race to ever-greater bandwidth.

More likely, wireless will fill the geographical and product gaps left open by the wireline network. New wireless technologies on the commercial horizon promise to do exactly this. 'Ultra wide-band wireless' technologies take advantage of under used frequencies scattered throughout the radio spectrum to deliver data. Other emerging wireless technologies do not use the electromagnetic spectrum at all. 'Free space optics,' for instance, transports information on low-power laser beams between two points within line of sight.

Many of these technologies are speculative and some are sure to fail. One technology that was touted as highly promising and attracted enormous financial backing a few years ago was satellite mobile phone. Launching dozens of low earth orbit and middle earth orbit satellites which function as cell sites streaming across the sky, these systems promised to reach the most remote regions on the globe. The systems were very costly to build, operate and maintain, and consequently resulted in very costly handsets and high per-minute rates. In the end, several well-financed projects lost billions of dollars and ended in bankruptcy– including Motorola's Iridium and ICO Global Communications. Furthermore, satellite Internet access services such as the one offered by Teledesic use telephone dialup access for the uplink portion of the connection.[169]

This is an important feature of all wireless technologies: while they can technically substitute for wireline service, they will not operate completely independent of the PSTN for

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[166] FCC, Sixth Report on Wireless Competition (2001, Table 4).

[167] OECD (2001) reports that presently all of the mobile communications industries of its 29 member countries are competitive when 23 of them were organized as monopolies a decade earlier.

[168] In fact, Federal law forbids taking account of CRMS when determining the extent of competition for wireline incumbents. Omnibus Budget Reconciliation Act of 1993, 47 U.S.C. 332.

[169] Two-way satellite high-speed data networks are being deployed however.

the foreseeable future. Even a connection that is wireless at both ends must travel through an earth-bound switch. Effectively fixed and mobile wireless technologies append a "radio tail" to a wireline network. To be of value to prospective users, a wireless network must physically interconnect with the PSTN so that the user can reach land-bound users. In that case the wireless providers must reach agreement with wireline networks to mutually terminate traffic at affordable rates. Progress has been made in this direction. In the U.S., law requires wireline common carriers to interconnect with commercial mobile radio services.[170] The WTO's Basic Agreement on Telecommunications also requires interconnection at non-discriminatory rates. Note that, until the TA96, cellular networks paid to receive traffic from ILECs as well as paying them to terminate mobile traffic. Another important obstacle, one that is crucial to entry into the residential market, is the absence of number portability between wireline and wireless systems, as well as among wireless carriers.

8. THE FUTURE OF LOCAL COMPETITION

Where market forces are allowed to operate, history shows that the local exchange industry tends to swing between monopoly and competition. Over the years, New York City illustrated this pattern in high relief. The current wave of competition in the U.S. and elsewhere is not unique, though it has proved to be more substantial, and it is likely to be more sustained than previous episodes.

While monopoly over local network markets has been the rule rather than the exception, competitive pressure on local services markets has been incessant. Often the assaults are indirect, attacking a narrow niche that is either outside the purview of regulators or beyond the principal interests of incumbent providers.[171] On occasion, these forays establish a beachhead that later expands to compete with the incumbent's core markets. This occurred when CAPs began as carriers' carriers and then gradually migrated into the delivery of switched services to homes and businesses.

Invariably at the source of successful entry is some technological advance that enables a new service or is a new way of delivering an existing service. A recent example is Internet telephony. IP telephony originally applied for international calling, but now it is emerging as an alternative platform for local calling, spurred on by the phenomenal growth of Internet instant messaging.

Market forces that drove the industry toward high concentration in the past nevertheless remain strong and pervasive today. Scale and scope economies deriving from network structure have not vanished. Network externalities that reward first movers and large incumbents are less prominent in mature telecommunications markets where penetration is nearly complete and all major networks are interconnected. Rather, in today's more competitive environment, the focus has turned to 'ownership' of retail customers. A product of supplier reputation and user switching costs, this demand side effect also works to the advantage of large-scale producers.

Policies that seek to inject competition into local network markets by sharing incumbent networks with rivals seek to have the best of both worlds. Unbundling of network services and resale of retail services preserve the benefits of unified production of network

[170] Omnibus Budget Reconciliation Act of 1993, 47 U.S.C. 332(c)(1)(B).
[171] Several examples of this pattern exist in data communications services.

services while at the same time facilitating competition for retail services. The same is true for policies of structural separation of network services.

From all indications these approaches have failed to take full account of the transaction costs incurred when sharing facilities and resources among competing providers. These transactions have triggered much haggling, contracting and monitoring, and in the worst cases, litigation and enforcement. The extent of the transaction costs, broadly interpreted, generated by implementation of the TA96 was clearly an unpleasant revelation for its framers.

An important source of these costs can be traced back to the misalignment of incentives of incumbent providers and new entrants. In the end, unbundling is an unnatural act for a vertically integrated provider. It is no surprise, therefore, that unbundling was virtually unknown prior to the recent opening the local exchange. Instead we saw fierce battles over interconnection of competing networks dating from the earliest days of the industry. Realistically, a goal of perfect interconnection, or the complete absence of discriminatory treatment of affiliated and unaffiliated partners, is unattainable. The embedded local networks we have today were optimized for exclusive use by a monopoly carrier, not for wholesale supply of unbundled elements or other network services.

The truth is, many geographic areas and customer segments—especially small markets with low population density, or customer groups with highly specialized service demands—are efficiently organized as monopolies. As a consequence, a prescription of ubiquitous competition may be no less harmful to social welfare than an integrated monopoly in each and every market.

In addition, service-based competition is inherently limited because competitors are restricted by the price, service and technology choices of the infrastructure owner. At best, over the long run, it offers a stepping stone to competitors on their way to building access networks of their own. Facilities-based competitors do not suffer from these same infirmities, and because of the durability of their investments, entry of this kind is more likely to have a sustained impact.

When existing networks are redeployed to provide local service (e.g., cable telephony and electric powerline systems), facilities-based entry can be relatively quick. These alternatives do not avoid the time and expense of negotiating interconnection agreements with incumbents, nor the risk of shifts in regulatory policy or legal rulings toward this kind of competition. But the incremental expense of entering with facilities, as well as reductions in associated sunk investment, make this a particularly effective and attractive competitor to incumbent carriers.

Experiments with open competition underway around the world offer tests of the relative merits of infrastructure and service competition. Comparison of the experience in the U.S. and U.K. is a case in point. Whereas the U.K. has favoured facilities-based entry ever since privatisation of BT, the U.S. was a leader in implementing network unbundling and resale. By the end of 1999, fixed line competitors were reported to have achieved a 15.4 percent share of access lines in the U.K., three times the 5.44 percent penetration achieved in the U.S. the majority of which is resold local loops.[172] Of course, market and institutional

[172] OECD (2001 Table 2.4). Recent survey results from the U.K. in early 2000 reveal that no fewer than 22 *percent* of households obtain a fixed line service exclusively from a competitive supplier, invariably a cable operator, with 28 *percent* taking some fixed line service from a BT competitor. See OFTEL (2000d, Figure 3a).

conditions differ significantly between the two countries, as did the development of incumbent and alternative networks at the time when local markets were opened to competition. Yet the similarities between the two countries were close enough to make the comparison instructive.

Facilities based competition faces its own obstacles quite aside from its enormous capital requirements. As with any network, facilities-based entrants must locate their equipment and links over land, under ground and through the air. Acquiring rights of way is essential, if often tedious, as when gaining access to building tops and riser space. Municipal authorities can be stingy with their public resources, and may even attempt to tax the new providers.

To tap the benefits of infrastructure competition, policy makers must resolve several difficult issues. Arguably less challenging than implementing service competition, regulators nevertheless must strive to extend symmetric treatment to different carriers, different regions and different services. Efficient policy toward incumbents and new entrants is particularly nettlesome, and the problem of incremental infrastructure investment poses sticky issues. Opening these facilities to competition will diminish incentives to build it in the first place, but if not, then competitors will necessarily stand at a competitive disadvantage. A good example of this is the 'next generation network' (NGN) that has been predicted for some time. This all-optical, all-packet network is intended to supplant the ageing PSTN but, given their position in the market, ILECs will build at least a portion of the NGN in all likelihood.

It seems inevitable that, in the end, any initiative to open local networks to competition must undergo a long, arduous transition period, especially coming after decades of regulated monopoly or state ownership. During this time, firms must learn how to compete, whether they are entrants seeking to break into local markets, or incumbents responding to the competitive threats. Consumers are coping with a wide array of providers and the plethora of services options and new technologies. Regulators must grope their way toward means to aid entry by new competitors without destroying investment incentives of incumbent carriers. At this time, too little history is available to draw inferences about the effects of alternative policies on local network markets. Time is needed before it is known how this process will operate and which policies are superior. Meanwhile, it is important to let the experiment run its natural course.

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