Urban Studies, Vol. 32, No. 2, 1995 361–378

Telecommunications and the Changing Geographies of Knowledge Transmission in the Late 20th Century

Barney Warf

[Paper first received, March 1994; in final form, July 1994]

Summary. Recent innovations in telecommunications and computing, enhanced by a global wave of deregulation and the emergence of post-Fordist production regimes, have unleashed profound transformations of various service sectors in the global economy. This paper first reviews the geographical repercussions of the explosion of information services, including the birth of electronic funds transfer systems, the growth of global cities and the dispersal of back offices to low-wage sites across the globe. Secondly, it explores the political economy and spatiality of the largest of these systems, the Internet. Thirdly, it summarises how the global division of labour has recently engendered the birth of 'new information spaces', places whose recent growth is contingent upon the introduction of telecommunications, citing as examples Singapore, Hungary and the Dominican Republic.

The late 20th century has witnessed an explosion of producer services on an historic scale, which forms a fundamental part of the much-heralded transition from Fordism to post-Fordism (Coffey and Bailly, 1991; Wood, 1991). Central to this transformation has been a wave of growth in financial and business services linked at the global level by telecommunications. The emergence of a global service economy has profoundly altered markets for, and flows of, information and capital, simultaneously initiating new experiences of space and time, generating a new round of what Harvey (1989, 1990) calls time–space convergence. More epistemologically, Poster (1990) notes that electronic systems change not only what we know, but how we know it.

The rapid escalation in the supply and demand of information services has been propelled by a convergence of several factors, including dramatic cost declines in information-processing technologies induced by the microelectronics revolution, national and worldwide deregulation of many service industries, including the Uruguay Round of GATT negotiations (which put services on the agenda for the first time), and the persistent vertical disintegration that constitutes a fundamental part of the emergence of post-Fordist production regimes around the world (Goddard and Gillespie, 1986; Garnham, 1990; Hepworth, 1990). The growth of traditional financial and business services, and the emergence of new ones, has ushered in a profound—indeed, an historic—transformation of the ways in which information is collected, processed and circulates, forming

Barney Warf is in the Department of Geography, Florida State University, Tallahassee, FL 32306-2050, USA.

0042-0980/95/020361-18

what Castells (1989) labels the 'informational mode of production'.

This paper constitutes an ambitious overview of the development, spatial dynamics and economic consequences of international telecommunications in the late 20th century as they arise from and contribute to the expansion of a global service economy. It opens with a broad perspective of recent changes in trade in producer services, particularly international finance, as the propelling force behind a large and rapidly expanding telecommunications infrastructure. Secondly, it explores the political economy of one of the largest and most renowned electronic systems, the Internet. Thirdly, it dwells upon the spatial dimensions of the mode of information, including the flowering of a select group of global cities, offshore banking centres, and the globalisation of clerical functions. Fourthly, it traces the emergence of what is called here 'new informational spaces', nations and regions reliant upon information services at the core of their economic development strategies. The conclusion summarises several themes that arise persistently in this discussion.

The Global Service Economy and Telecommunications Infrastructure

There can be little doubt that trade in services has expanded rapidly on an international basis (Kakabadse, 1987), comprising roughly one-quarter of total international trade. Internationally, the US is a net exporter of services (but runs major trade deficits in manufactured goods), which is one reason why services employment has expanded domestically. Indeed, it could be said that as the US has lost its comparative advantage in manufacturing, it has gained a new one in financial and business services (Noyelle and Dutka, 1988; Walter, 1988). The data on global services trade are poor, but some estimates are that services comprise roughly one-third of total US exports, including tourism, fees and royalties, sales of business services and profits from bank loans.

From the perspective of contemporary social theory, services may be viewed within the context of the enormous series of changes undergone by late 20th-century capitalism. In retrospect, the signs of this transformation are not difficult to see: the collapse of the Bretton-Woods agreement in 1971 and the subsequent shift to floating exchange rates; the oil crises of 1974 and 1979, which unleashed $375b of petrodollars between 1974 and 1981 (Wachtel, 1987), and the resulting recession and stagflation in the West; the explosive growth of Third World debt, including a secondary debt market and debt–equity swaps (Corbridge, 1984), the growth of Japan as the world's premier centre of financial capital (Vogel, 1986); the explosion of the Euromarket (Pecchioli, 1983; Walter, 1988); the steady deterioration in the competitive position of industrial nations, particularly the US and the UK, and the concomitant rise of Japan, Germany and the newly industrialising nations, particularly in east Asia; the transformation of the US under the Reagan administration into the world's largest debtor, the emergence of flexible production technologies (e.g. just-in-time inventory systems) and computerisation of the workplace; the steady growth of multinational corporations and their ability to shift vast resources across national boundaries; the global wave of deregulation and privatisation that lay at the heart of Thatcherite and Reaganite post-Keynesian policy; and finally, the integration of national financial markets through telecommunications systems. In the 1990s, one might add the collapse of the Soviet bloc and the steady integration of those nations into the world economy. This series of changes has been variably labelled an 'accumulation crisis' in the transition from state monopoly to global capitalism (Graham *et al.*, 1988), or the end of one Kondratieff long wave and the beginning of another (Marshall, 1987). What is abundantly clear from these observations is the emergence of a new global division of labour, in which services play a fundamental role.

The increasing reliance of financial and business services as well as numerous multinational manufacturing firms upon telecom-

munications to relay massive volumes of information through international networks has made electronic data collection and transmission capabilities a fundamental part of regional and national attempts to generate a comparative advantage (Gillespie and Williams, 1988). The rapid deployment of such technologies reflects a conjunction of factors, including: the increasingly information-intensive nature of commodity production in general (necessitating ever larger volumes of technical data and related inputs on financing, design and engineering, marketing and so forth); the spatial separation of production activities in different nations through globalised sub-contracting networks; decreases in price and the elastic demand for communications; the birth of new electronic information services (e.g. on-line databases, teletext and electronic mail); and the high levels of uncertainty that accompany the international markets of the late 20th century, to which the analysis of large volumes of data is a strategic response (Moss, 1987b; Akwule, 1992). The computer networks that have made such systems technologically and commercially feasible offer users scale and scope economies, allowing spatially isolated establishments to share centralised information resources such as research, marketing and advertising, and management (Hepworth, 1986, 1990). Inevitably, such systems have profound spatial repercussions, reducing uncertainty for firms and lowering the marginal cost of existing plants, especially when they are separated from one another and their headquarters over long distances, as is increasingly the case.

Central to the explosion of information services has been the deployment of new telecommunications systems and their merger with computerised database management (Nicol, 1985). This phenomenon can be seen in no small part as an aftershock of the microelectronics revolution and the concomitant switch from analogue to digital information formats: the digital format suffers less degradation over time and space, is much more compatible with the binary constraints of computers, and allows greater privacy (Akwule, 1992). As data have been converted from analogue to digital forms, computer services have merged with telecommunications. When the cost of computing capacity dropped rapidly, communications became the largest bottleneck for information-intensive firms such as banks, securities brokers and insurance companies. Numerous corporations, especially in financial services, invested in new communications technologies such as microwave and fibre optics. To meet the growing demand for high-volume telecommunications, telephone companies upgraded their copper-cable systems to include fibre-optics lines, which allow large quantities of data to be transmitted rapidly, securely and virtually error-free. By the early 1990s, the US fibre-optic network was already well in place (Fig. l). In response to the growing demand for international digital data flows beginning in the 1970s, the United Nation's International Telecommunications Union introduced Integrated Service Digital Network (ISDN) to harmonise technological constraints to data flow among its members (Akwule, 1992). ISDN has since become the standard model of telecommunications in Europe, North America and elsewhere.

The international expansion of telecommunications networks has raised several predicaments for state policy at the global and local levels. This topic is particularly important because, as we shall see, state policy both affects and is affected by the telecommunications industry. At the international level, issues of transborder data flow, intellectual property rights, copyright laws, etc., which have remained beyond the purview of traditional trade agreements, have become central to GATT and its successor, the International Trade Organization. At the national level, the lifting of state controls in telecommunications had significant impacts on the profitability, industrial organisation and spatial structure of information services. In the US, for example, telecommunications underwent a profound reorganisation following the dissolution of ATT's monopoly in 1984, leading to secular declines in the price

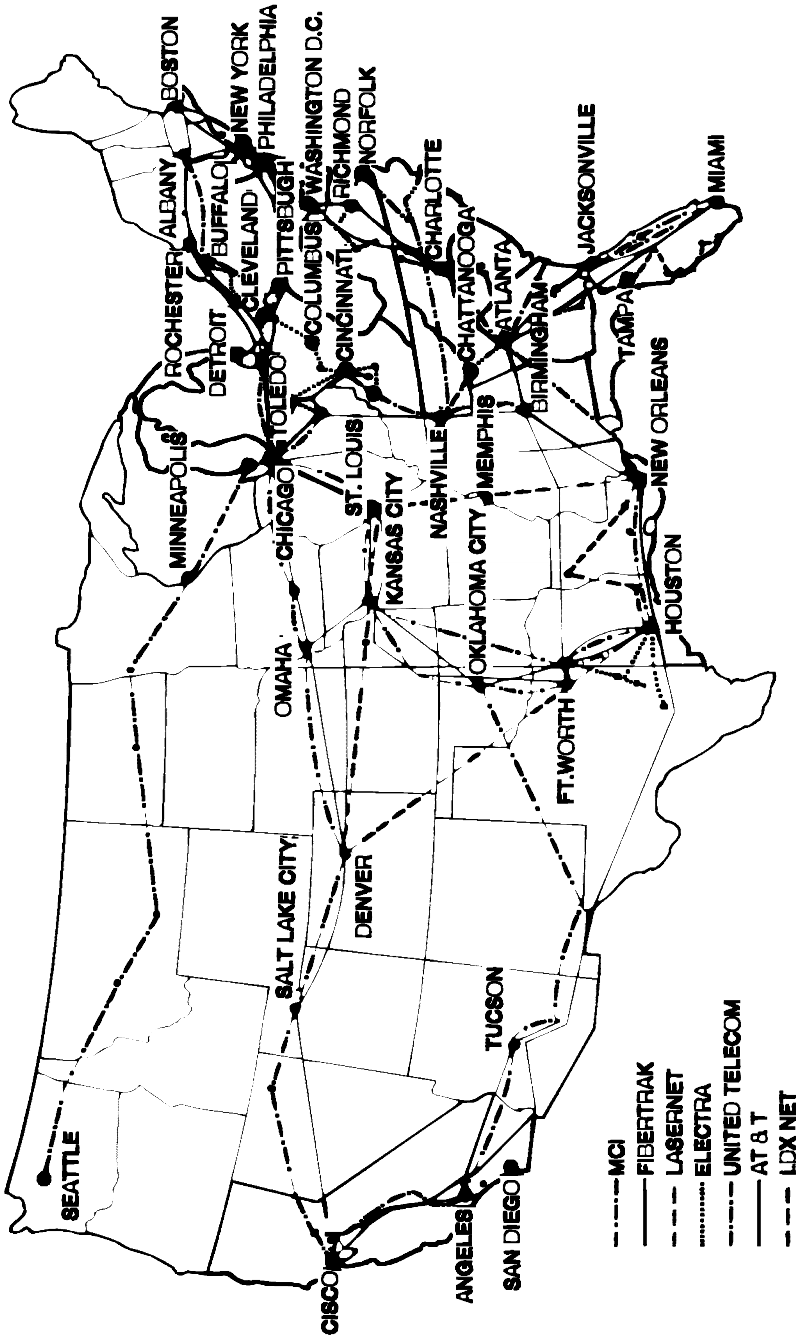

Figure 1. The US fibre-optics network, 1992. *Source:* Office of Technology Assessment (1993).

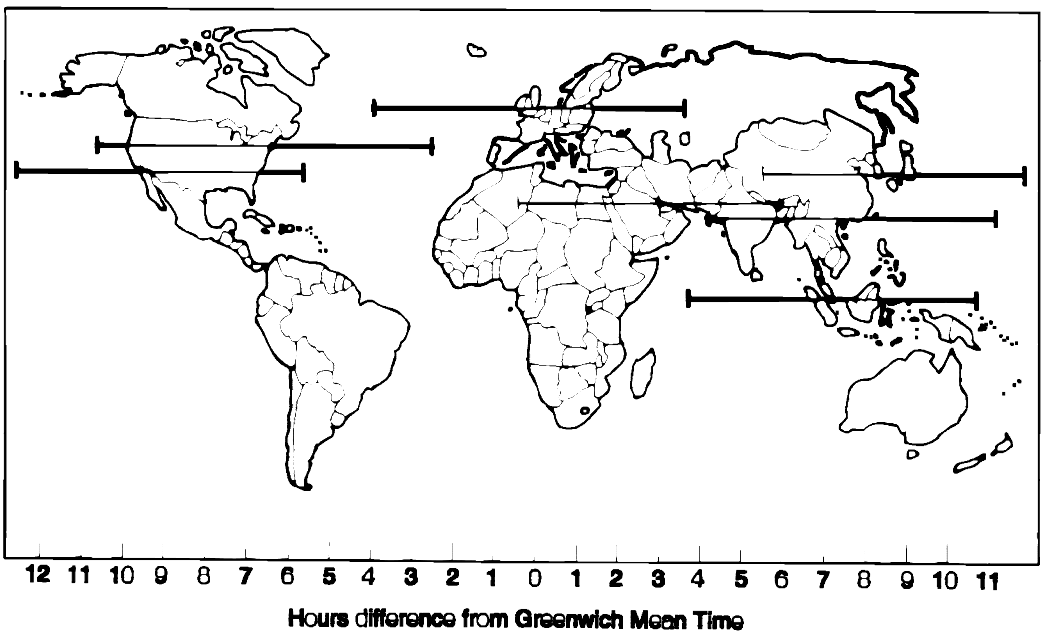

Figure 2. Trading hours of major world financial centres.

of long-distance telephone calls. Likewise, the Thatcher government privatised British Telecom, and even the Japanese began the deregulation of Nippon Telegraph and Telephone.

Telecommunications allowed not only new volumes of inter-regional trade in data services, but also in capital services. Banks and securities firms have been at the forefront of the construction of extensive leased telephone networks, giving rise to electronic funds transfer systems that have come to form the nerve centre of the international financial economy, allowing banks to move capital around a moment's notice, arbitraging interest rate differentials, taking advantage of favourable exchange rates, and avoiding political unrest (Langdale, 1985, 1989; Warf, 1989). Citicorp, for example, erected its Global Telecommunications Network to allow it to trade $200bn daily in foreign exchange markets around the world. Such networks give banks an ability to move money—by some estimates, more than $1.5 trillion daily (*Insight*, 1988)—around the globe at stupendous rates. Subject to the process of digitisation, information and capital become two sides of the same coin. In the securities markets, global telecommunications systems have also facilitated the emergence of the 24-hour trading day, linking stock markets through the computerised trading of stocks. Reuters and the Chicago Mercantile Exchange announced the formation of Globex, an automated commodities trading system, while in 1993 the New York stock exchange began the move to a 24-hour day automated trading system. As Figure 2 indicates, the world's major financial centres are easily connected even with an 8-hour trading day. The volatility of stock markets has increased markedly as hair-trigger computer trading programmes allow fortunes to be made (and lost) by staying microseconds ahead of (or behind) other markets, as exemplified by the famous crashes of 19 October 1987. It is vital to note that heightened volatility, or the ability to switch vast quantities of funds over enormous distances, is fundamental to these capital markets: speculation is no fun when there are no wild swings in prices (Strange, 1986).

Within the context of an expanding and ever more integrated global communications network, a central role in the formation of local competitive advantage has been attained by teleports, which are essentially office parks equipped with satellite earth stations and usually linked to local fibre-optics lines (Lipman *et al.*, 1986; Hanneman, 1987a, 1987b and 1987c). The World Teleport Association defines a teleport as:

> An access facility to a satellite or other long-haul telecommunications medium, incorporating a distribution network serving the greater regional community and associated with, including, or within a comprehensive real estate or other economic development. (Hanneman, 1987a, p. 15)

Just as ports facilitate the transshipment of cargo and airports are necessary for the movement of people, so too do teleports serve as vital information transmission facilities in the age of global capital. Because telecommunications exhibit high fixed costs and low marginal costs, teleports offer significant economies of scale to small users unable to afford private systems (Stephens, 1987; Burstyn, 1986). Teleports apparently offer a continually declining average cost curve for the provision of telecommunications services. Such a cost curve raises important issues of pricing and regulation, including the tendency of industries with such cost structures to form natural monopolies. Government regulation is thus necessary to minimise inefficiencies, and the pricing of telecommunications services becomes complex (i.e. marginal revenues do not equal marginal costs, as in non-monopolistic, non-regulated sectors) (Rohlfs, 1974; Saunders *et al.*, 1983; Guldmann, 1990).

In the late 1980s there were 54 teleports in the world, including 36 in the US (Hanneman, 1987a). Most of these are concentrated in the industrialised world, particularly in cities in which data-intensive financial and business services play a major economic role. In Europe, London's new teleport in the Docklands will ensure that city's status as the centre of the Euromarket for the near future; Hamburg, Cologne, Amsterdam and Rotterdam are extending telematic control across Europe.

Tokyo is currently building the world's largest teleport. In the 1980s, the Japanese government initiated a series of high-technology 'technopolises' that form part of a long-term 'teletopia' plan to encourage decentralisation of firms out of the Tokyo region to other parts of the nation (Rimmer, 1991). In 1993 the city initiated the Tokyo Teleport on 98 ha of reclaimed land in Tokyo harbour (Tokyo Metropolitan Government Planning Department, 1993). The teleport's 'intelligent buildings' (those designed to accommodate fibre optics and advanced computational capacity), particularly its Telecom Centre, are designed to accommodate ISDN requirements. Wide Area Networks (WANs) provide local telecommunications services via microwave channels, as do Value Added Networks on fibre-optic routes. The site was originally projected to expand to 340 ha, including office, waterfront and recreational functions, and employ 100 000 people, but may be scaled back in the light of the recent recessionary climate there.

The world's first teleport is named, simply, The Teleport, located on Staten Island, New York, a project jointly operated by Merrill Lynch and the Port Authority of New York and New Jersey. Built in 1981, The Teleport consists of an 11-acre office site and 16 satellite earth stations, and is connected to 170 miles of fibre-optic cables throughout the New York region, which are, in turn, connected to the expanding national fibre-optic network. Japanese firms have taken a particularly strong interest in The Teleport, comprising 18 of its 21 tenants. For example, Recruit USA, a financial services firm, uses it to sell excess computer capacity between New York and Tokyo, taking advantage of differential day and night rates for supercomputers in each city by transmitting data via satellite and retrieving the results almost instantaneously (Warf, 1989).

In addition to the US, European and

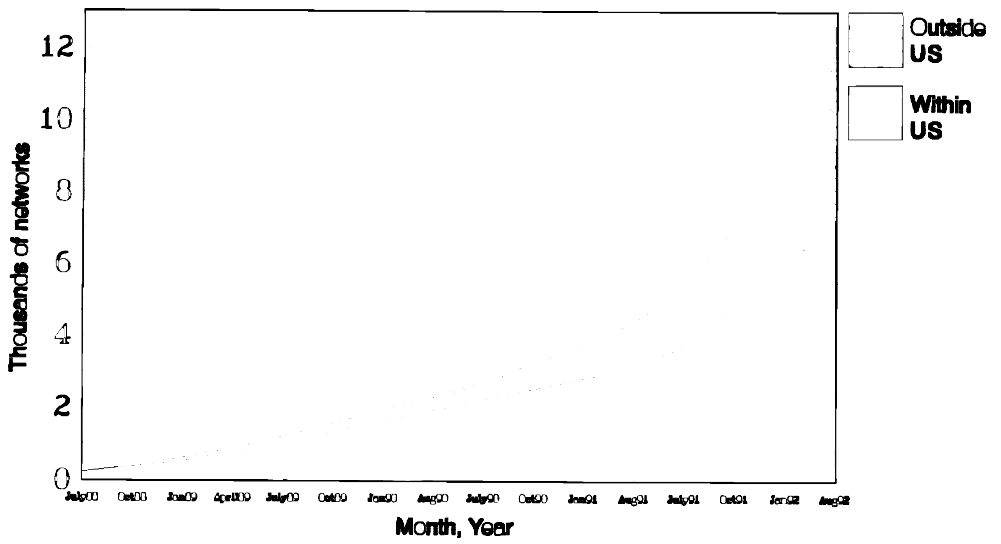

Figure 3. Growth of Internet. *Source:* Broad (1993).

Japanese teleports, some Third World nations have invested in them in order to secure a niche in the global information services economy. Jamaica, for example, built one at Montego Bay to attract American 'back office' functions there (Wilson, 1991). Other examples include Hong Kong, Singapore, Bahrain and Lagos, Nigeria (Warf, 1989).

The Internet: Political Economy and Spatiality of the Information Highway

Of all the telecommunications systems that have emerged since the 1970s, none has received more public adulation than the Internet. The unfortunate tendency in the popular media to engage in technocratic utopianism, including hyperbole about the birth of cyberspace and virtual reality, has obscured the very real effects of the Internet. The Internet is the largest electronic network on planet, connecting an estimated 20m people in 40 countries (Broad, 1993). Further, the Internet has grown at rapid rates, doubling in networks and users every year (Figure 3); by mid 1992, it connected more than 12 000 individual networks worldwide. Originating as a series of public networks, it now includes a variety of private systems of access, in the US including services such as Prodigy, CompuServe or America On-Line (Lewis, 1994), which allow any individual with a microcomputer and modem to 'plug in', generating a variety of 'virtual communities'. By 1994, such services connected almost 5m people in the US alone (Lewis, 1994).

The origins of the Internet can be traced back to 1969, when the US Department of Defense founded ARPANET, a series of electronically connected computers whose transmission lines were designed to withstand a nuclear onslaught (Schiller, 1993). Indeed, the very durability and high quality of much of today's network owes its existence to its military origins. In 1984, ARPANET was expanded and opened to the scientific community when it was taken over by the National Science Foundation, becoming NSFNET, which linked five supercomputers around the US (Figure 4). The Internet, which emerged upon a global scale via its integration with existing telephone, fibre-optic and satellite systems, was made possible by the technological innovation of packet switching, in which individual messages may be decomposed, the constituent parts transmitted by various channels (i.e. fibre optics, telephone lines, satellite), and

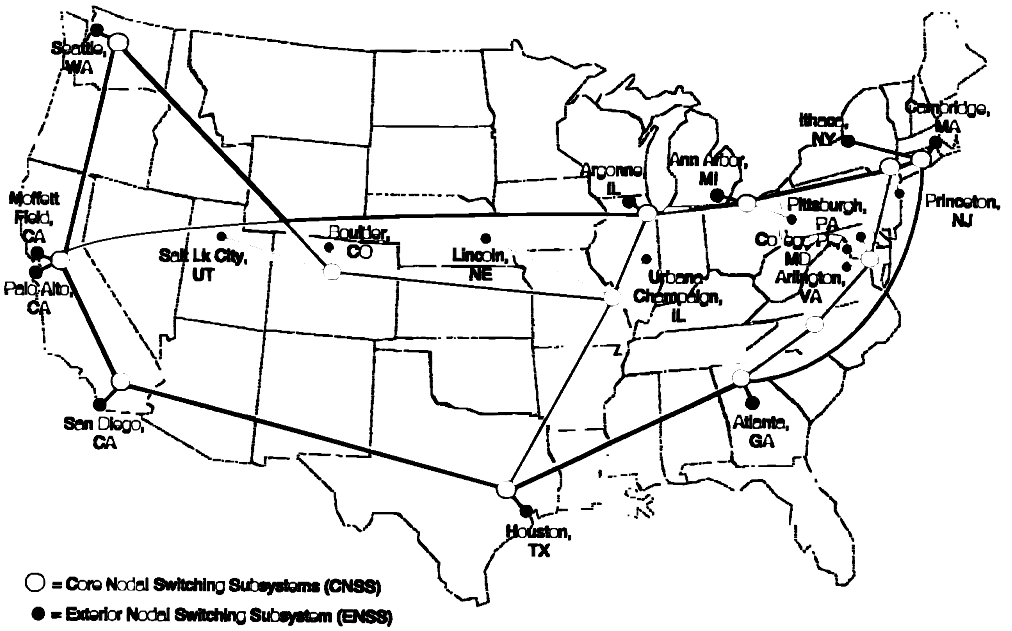

Figure 4. Distribution of NSFNET Backbone Service. *Source:* Office of Technology Assessment (1993).

then reassembled, seamlessly and instantaneously, at the destination. In the 1990s such systems have received new scrutiny as central elements in the Clinton administration's emphasis on 'information superhighways'.

The Internet has become the world's single most important mechanism for the transmission of scientific and academic knowledge. Roughly one-half of all of its traffic is electronic mail, while the remainder consists of scientific documents, data, bibliographies, electronic journals and bulletin boards (Broad, 1993). Newer additions include electronic versions of newspapers, such as the *Chicago Tribune* and *San Jose Mercury News*, as well as an electronic library, the World Wide Web. In contrast to the relatively slow and bureaucratically monitored systems of knowledge production and transmission found in most of the world, the Internet and related systems permit a thoroughly unfiltered, non-hierarchical flow of information best noted for its lack of overlords. Indeed, the Internet has spawned its own unregulated counterculture of 'hackers' (Mungo and Clough, 1993). However, the system finds itself facing the continuous threat of commercialisation as cyberspace is progressively encroached upon by corporations, giving rise, for example, to new forms of electronic shopping and 'junk mail' (Weis, 1992). The combination of popular, scientific and commercial uses has led to an enormous surge in demand for Internet capacities, so much so that they frequently generate 'traffic jams on the information highway' as the transmission circuits become overloaded (Markoff, 1993).

Despite the mythology of equal access for everyone, there are also vast discrepancies in access to the Internet at the global level (Schiller, 1993; Cooke and Lehrer, 1993). As measured by the number of access nodes in each country, it is evident that the greatest Internet access remains in the most economically developed parts of the world, notably North America, Europe and Japan (Figure 5). The hegemony of the US is particularly notable given that 90 per cent of Internet traffic is destined for or originates in that nation. Most of Africa, the Middle East and Asia (with the exceptions of India, Thailand and Malaysia),

in contrast, have little or no access. There is, clearly, a reflection here of the long-standing bifurcation between the First and Third Worlds. To this extent, it is apparent than the geography of the Internet reflects previous rounds of capital accumulation—i.e. it exhibits a spatiality largely preconditioned by the legacy of colonialism.

There remains a further dimension to be explored here, however, the bifurcation between the superpowers following World War II. As Buchner (1988) noted, Marxist regimes favoured investments in television rather than telephone systems: televisions, allowing only a one-way flow of information (i.e. government propaganda), are far more conducive to centralised control that are telephones, which allow multiple parties to circumvent government lines of communication. Because access to the Internet relies heavily upon existing telephone networks, this policy has hampered the emerging post-Soviet 'Glasnet'. Superimposed on top of the landscapes of colonialism, therefore, is the landscape of the Cold War.

A rather curious yet revealing byproduct of the Internet's expansion concerns the international transmission of computer viruses, programmes written deliberately to interfere with the operations of other software systems. Although viruses are not new to users of computers, the rapid growth of electronic systems in the 1980s has markedly accelerated their capacity to travel internationally, indicating both the extent and speed with which knowledge circulates through such networks as well as the vulnerability of these systems to unwanted intrusions. In 1992, for example, the Michelangelo virus disrupted software systems of users ranging from South African pharmacists to the San Francisco police department. More ominous is the 'Bulgarian virus machine' (Mungo and Clough, 1993). In the 1980s, Bulgaria was the designated computer producer for the Soviet bloc, and Sofia University produced large numbers of skilled engineers and programmers to serve it. As communism collapsed in the late 1980s, many of such individuals, including bored young men who comprise the vast bulk of hackers, took to writing viruses and releasing them on international networks, including those of the UN. Simultaneously, Sofia University began to export its anti-virus software on the world market. Although some of the worst excesses of Bulgarian hackers have been curtailed, some indications are that they are being joined by Russian, Thai and other counterparts.

Geographical Consequences of the Mode of Information

As might be expected, the emergence of a global economy hinging upon producer services and telecommunications systems has led to new rounds of uneven development and spatial inequality. Three aspects of this phenomenon are worth noting here, including the growth of world cities, the expansion of offshore banking centres and the globalisation of back offices.

World Cities

The most readily evident geographical repercussions of this process have been the growth of 'world cities', notably London, New York and Tokyo (Moss, 1987a; Sassen, 1991), each of which seems to be more closely attuned to the rhythms of the international economy than the nation-state in which it is located. In each metropolitan area, a large agglomeration of banks and ancillary firms generates pools of well-paying administrative and white-collar professional jobs; in each, the incomes of a wealthy stratum of traders and professionals have sent real estate prices soaring, unleashing rounds of gentrification and a corresponding impoverishment for disadvantaged populations. While such predicaments are not new historically—Amsterdam was the Wall Street of the 17th century (Rodriguez and Feagin, 1986)—the magnitude and rapidity of change that global telecommunications have unleashed in such cities is without precedent.

London, for example, boomed under the

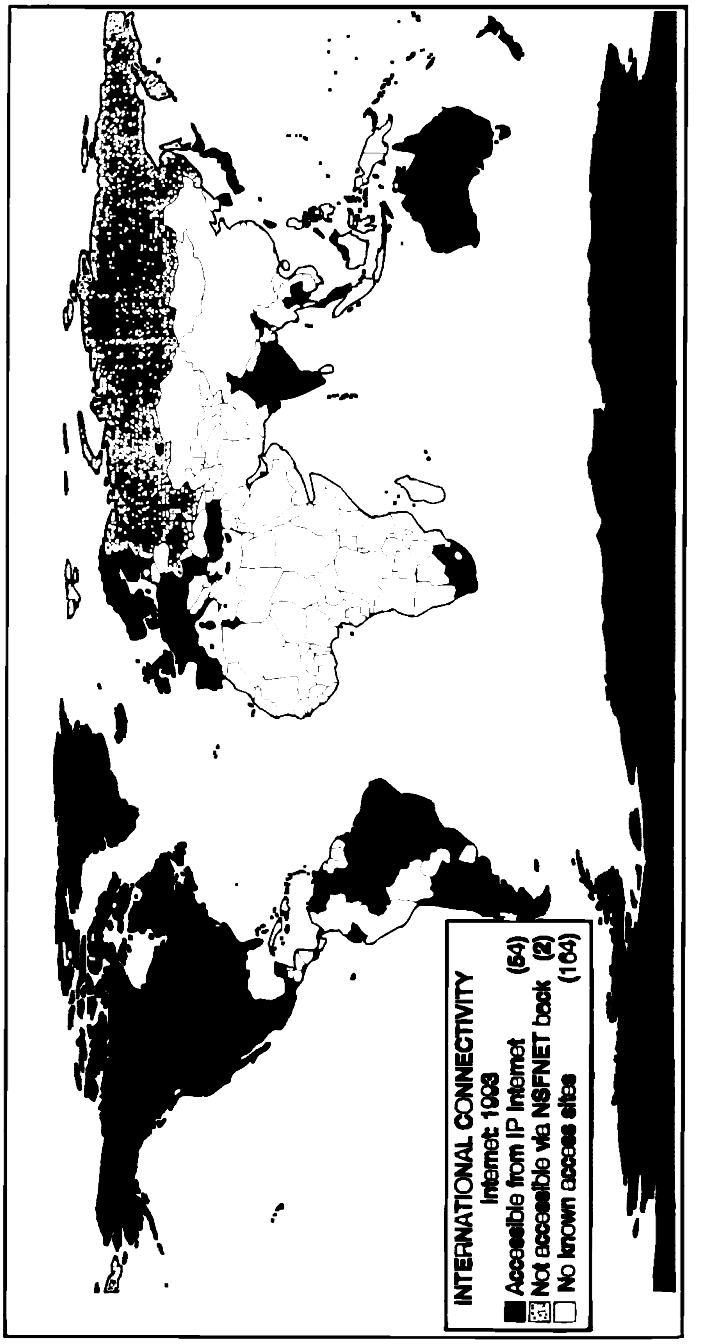

Figure 5. The geography of access to the Internet, 1993. *Source:* unpublished data from the Internet Supervisory Oversight Committee.

impetus of the Euromarket in the 1980s, and has become detached from the rest of Britain (Thrift, 1987; Budd and Whimster, 1992). Long the centre of banking for the British Empire, and more recently the capital of the unregulated Euromarket, London seems to have severed its moorings to the rest of the UK and drifted off into the hyperspaces of global finance. State regulation in the City—always loose when compared to New York or Tokyo—was further diminished by the 'Big Bang' of 1986. Accordingly, the City's landscape has been reshaped by the growth of offices, most notably Canary Wharf and the Docklands. Still the premier financial centre of Europe, and one of the world's major centres of foreign banking, publishing and advertising, London finds its status challenged by the growth of Continental financial centres such as Amsterdam, Paris and Frankfurt.

Similarly, New York rebounded from the crisis of the mid 1970s with a massive influx of petrodollars and new investment funds (i.e. pension and mutual funds) that sustained a prolonged bull market on Wall Street in the 1980s (Scanlon, 1989; Mollenkopf and Castells, 1992; Shefter, 1993). Today, 20 per cent of New York's banking employment is in foreign-owned firms, notably Japanese giants such as Dai Ichi Kangyo. Driven by the entrance of foreign firms and increasing international linkages, trade on the New York stock exchange exploded from 12m shares per day in the 1970s to 150m in the early 1990s (Warf, 1991). New York also boasts of being the communications centre of the world, including one-half million jobs that involve the collection, production, processing, transmission or consumption of information in one capacity or another (Warf, 1991). This complex, including 60 of the largest advertising and legal services firms in the US, is fuelled by more word-processing systems than in all of Europe combined. The demand for space in such a context has driven an enormous surge of office construction, housing 60 headquarters of US Fortune 500 firms. Currently, 20 per cent of New York's office space is foreign-owned, testimony to the need of large foreign financial firms to establish a presence there.

Tokyo, the epicentre of the gargantuan Japanese financial market, is likely the world's largest centre of capital accumulation, with one-third of the world's stocks by volume and 12 of its largest banks by assets (Masai, 1989). The Tokyo region accounts for 25 per cent of Japan's population, but a disproportionate share of its economic activity, including 60 per cent of the nation's headquarters, 65 per cent of its stock transactions, 89 per cent of its foreign corporations, and 65 per cent of its foreign banks (Cybriwsky, 1991). Tokyo's growth is clearly tied to its international linkages to the world economy, particularly in finance, a reflection of Japan's growth as a major world economic power (Masai, 1989; Cybriwsky, 1991). In the 1980s, Japan's status in the global financial markets was unparalleled as the world's largest creditor nation (Vogel, 1986; *Far Eastern Economic Review*, 1987). Tokyo's role as a centre of information-intensive activities includes a state-of-the-art telecommunications infrastructure, including the CAPTAIN (Character and Pattern Telephone Access Information Network) system (Nakamura and White, 1988).

Offshore Banking

A second geographical manifestation of the new, hypermobile capital markets has been the growth of offshore banking, financial services outside the regulation of their national authorities. Traditionally, 'offshore' was synonymous with the Euromarket, which arose in the 1960s as trade in US dollars outside the US. Given the collapse of Bretton Woods and the instability of world financial markets, the Euromarket has since expanded to include other currencies as well as other parts of the world. The recent growth of offshore banking centres reflects the broader shift from traditional banking services (loans and deposits) to lucrative, fee-based non-traditional functions, including debt repackaging foreign exchange transactions and cash management (Walter, 1989).

Today, the growth of offshore banking has occurred in response to favourable tax laws in hitherto marginal places that have attempted to take advantage of the world's uneven topography of regulation. As the technological barriers to capital have declined, the importance of political ones has thus risen concomitantly. Several distinct clusters of offshore banking may be noted, including, in the Caribbean, the Bahamas and Cayman Islands; in Europe, Switzerland, Luxembourg and Liechtenstein; in the Middle East, Cyprus and Bahrain; in southeast Asia, Singapore and Hong Kong; and in the Pacific Ocean, Vanuatu, Nauru and Western Samoa. Roberts (1994, p. 92) notes that such places "are all part of a worldwide network of essentially marginal places which have come to assume a crucial position in the global circuits of fungible, fast-moving, furtive money and fictitious capital." Given the extreme mobility of finance capital and its increasing separation from the geography of employment, offshore banking can be expected to yield relatively little for the nations in which it occurs; Roberts (1994), for example, illustrates the case of the Cayman Islands, now the world's fifth-largest banking centre in terms of gross assets, where 538 foreign banks employ only 1000 people (less than two apiece). She also notes that such centres are often places in which 'hot money' from illegal drug sales or undeclared businesses may be laundered.

Offshore markets have also penetrated the global stock market, where telecommunications may threaten the agglomerative advantages of world cities even as they reinforce them. For example, the National Associated Automated Dealers Quotation System (NASDAQ) has emerged as the world's fourth-largest stock market; unlike the New York, London, or Tokyo exchanges, NASDAQ lacks a trading floor, connecting half a million traders worldwide through telephone and fibre-optic lines. Similarly, Paris, Belgium, Spain, Vancouver and Toronto all recently abolished their trading floors in favour of screen-based trading.

Global Back Offices

A third manifestation of telecommunications in the world service economy concerns the globalisation of clerical services, in particular back offices. Back offices perform many routinised clerical functions such as data entry of office records, telephone books or library catalogues, stock transfers, processing of payroll or billing information, bank cheques, insurance claims, magazine subscriptions and airline frequent-flyer coupons. These tasks involve unskilled or semi-skilled labour, primarily women, and frequently operate on a 24-hour-per-day basis (Moss and Dunau, 1986). By the mid 1980s, with the conversion of office systems from analogue to digital form largely complete, many firms began to integrate their computer systems with telecommunications.

Historically, back offices have located adjacent to headquarters activities in downtown areas to ensure close management supervision and rapid turnaround of information. However, under the impetus of rising central-city rents and shortages of sufficiently qualified (i.e. computer-literate) labour, many service firms began to uncouple their headquarters and back office functions, moving the latter out of the downtown to cheaper locations on the urban periphery. Most back office relocations, therefore, have been to suburbs (Moss and Dunau, 1986; Nelson, 1986). Recently, given the increasing locational flexibility afforded by satellites and a growing web of inter-urban fibre-optics systems, back offices have begun to relocate on a much broader, continental scale. Under the impetus of new telecommunications systems, many clerical tasks have become increasingly footloose and susceptible to spatial variations in production costs. For example, several firms fled New York City in the 1980s: American Express moved its back offices to Salt Lake City, UT, and Phoenix, AZ; Citicorp shifted its Mastercard and Visa divisions to Tampa, FL, and Sioux Falls, SD, and moved its data processing functions to Las Vegas, NV, Buffalo, NY, Hagerstown, MD, and Santa Monica, CA; Citibank moved

its cash management services to New Castle, DE; Chase Manhattan housed its credit card operations in Wilmington; Hertz relocated its data entry division to Oklahoma City; Avis went to Tulsa. Dean Witter moved its data processing facilities to Dallas, TX; Metropolitan Life repositioned its back offices to Greenville, SC, Scranton, PA, and Wichita, KS; Deloitte Haskins Sells relocated its back offices to Nashville, TN; and Eastern Airlines chose Miami, FL.

Internationally, this trend has taken the form of the offshore office (Wilson, 1991). The primary motivation for offshore relocation is low labour costs, although other considerations include worker productivity, skills, turnover and benefits. Offshore offices are established not to serve foreign markets, but to generate cost savings for US firms by tapping cheap Third World labour pools. Notably, many firms with offshore back offices are in industries facing strong competitive pressures to enhance productivity, including insurance, publishing and airlines. Offshore back office operations remained insignificant until the 1980s, when advances in telecommunications such as trans-oceanic fibre-optics lines made possible greater locational flexibility just when the demand for clerical and information processing services grew rapidly (Warf, 1993). Several New York-based life insurance companies, for example, have erected back office facilities in Ireland, with the active encouragement of the Irish government (Lohr, 1988). Often situated near Shannon Airport, they move documents in by Federal Express and the final product back via satellite or the TAT-8 fibre-optics line that connected New York and London in 1989 (Figure 6). Despite the fact that back offices have been there only a few years, Irish development officials already fret, with good reason, about potential competition from Greece and Portugal. Likewise, the Caribbean has become a particularly important locus for American back offices, partly due to the Caribbean Basin Initiative instituted by the Reagan administration and the guaranteed access to the US market that it provides. Most back offices in the Caribbean have chosen Anglophonic nations, particularly Jamaica and Barbados. American Airlines has paved the way in the Caribbean through its subsidiary Caribbean Data Services (CDS), which began when a data processing centre moved from Tulsa to Barbados in 1981. In 1987, CDS opened a second office near Santo Domingo, Dominican Republic, where wages are one-half as high as Barbados (Warf, forthcoming). Thus, the same flexibility that allowed back offices to move out of the US can be used against the nations to which they relocate.

New Information Spaces

The emergence of global digital networks has generated growth in a number of unanticipated places. These are definitely not the new industrial spaces celebrated in the literature on post-Fordist production complexes (Scott, 1988), but constitute new 'information spaces' reflective of the related, yet distinct, mode of information. Three examples— Singapore, Hungary and the Dominican Republic— illustrate the ways in which contemporary telecommunications generate repercussions in the least expected of places.

Singapore

Known best perhaps as a member of the East Asian newly industrialised countries (NICs), Singapore today illustrates what may be the most advanced telecommunications infrastructure in the world, creating an 'intelligent island' with high-speed leased circuits, a dense telephone and fibre-optic network, household teleboxes for electronic mail and ubiquitous remote computer access (Dicken, 1987; Corey, 1991). Singapore's government has led the way in this programme through its National Computer Board and Telecommunications Authority. This transformation has occurred as part of a sustained shift in the island's role from unskilled, low-wage assembly functions to exporter of high value-added business services and as the financial hub of south-east Asia, a process hastened by the flight of capital from Hong Kong

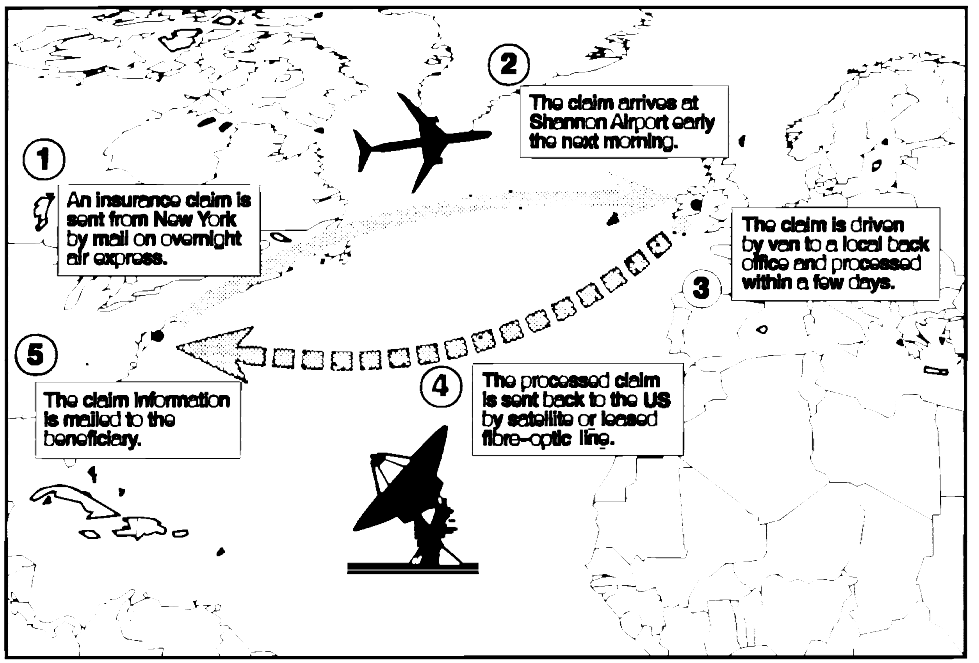

Figure 6. Mechanics of back office relocation to Ireland.

(Jussawalla and Cheach, 1983). Exports of services have now become Singapore's largest industry in terms of employment and foreign revenues. Reuters, for example, uses Singapore as its news hub in south-east Asia. In part, this transformation reflects the island's relatively high wages and fears of competition from its larger neighbours. Today, more than one-third of Singapore's labour force is engaged in skilled, white-collar employment. In addition, Singapore uses its telecommunications network for advanced Electronic Data Interchange (EDI) services to facilitate maritime shipping, in congruence with its status as the world's largest port.

Hungary

Before the collapse of the Soviet Union, Hungary suffered many of the same telecommunications problems as other underdeveloped nations: outdated technology, unsatisfied demand and few advanced services. Today, largely due to deregulation and foreign investment, the Hungarian telecommunications system is the most advanced in the former Soviet bloc, subsuming 10 per cent of the nation's total investment capital. The leader in this process has been the postal service, Magyar Posta, and its successor, the Hungarian Telecommunications Company (Matav), which introduced innovative pricing based on market, not political criteria, fees for telephone connections, time-differentiated and distance-sensitive pricing and bond financing. Concomitantly, an administrative reorganisation decentralised control of the firm, breaking the inefficient stranglehold of the bureaucratic, Communist *apparatchik* (Whitlock and Nyevrikel, 1992). The birth of the new Hungarian telecommunications network was invaluable to the nation's emerging financial system, centred in Budapest, which has expanded beyond simple loans and stocks to include database management and stock transfers (Tardos, 1991). Thus, in this respect, Hungary serves as a model for other nations making the transition from state socialism to market economies.

The Dominican Republic

In the 1980s, the Dominican government introduced a policy designed to develop non-traditional exports, particularly tourism and information services, as part of a strategy to reduce the country's reliance upon agricultural exports. For a small, relatively impoverished nation, the nation possesses a well-endowed information services infrastructure (Warf, forthcoming). The national telephone company Codetel (Compania Dominicana de Telecommunicaciones), for example, has provided the Dominican Republic with near-universal telephone access, high-speed data transmission services on fibre-optics lines, digital switching equipment, cellular telephones and microwave service to all neighbouring nations except Cuba. Codetel also sells a variety of high value-added services such as electronic mail and databases, telex, remote terminals, facsimile services, Spanish–English translations and leased lines. This infrastructure has made the Dominican Republic the most advanced nation in telecommunications in Latin America and has attracted numerous foreign firms. IBM-Santo Domingo, for example, engages in a complex, worldwide system of sub-contracting with its subsidiaries, purchasing, for example, printers from Argentina, disk drives from Brazil, CPUs from the US or Brazil and software, written in Canada, the US and Denmark, through its distributor in Mexico. A similar firm is Infotel, which performs a variety of computer-related functions for both domestic and international clients, including compilation of telephone directories, photocomposition, data conversion, computerised, on-line sale of advertising images, desktop publishing and map digitising. Infotel serves a variety of domestic and foreign clients, including Dominican utilities and municipal governments, the GTE telephone-operating companies, the US Geological Survey and the Spanish telephone network. Another service attracted to the Dominican Republic is back offices. American Airlines, and its subsidiary Caribbean Data Services, processes medical and dental insurance claims, credit card applications, retail sales inventories, market surveys and name and address listings at a Free Trade Zone near the capital.

Concluding Comments

What lessons can be drawn from these observations about the emergence of a globalised service economy and the telecommunications networks that underpin it? As part of the broad sea-change from Fordist production regimes to the globalised world of flexible accumulation, about which so much has already been said, it is clear that capital—as data or cash, electrons or investments—in the context of global services has acquired a qualitatively increased level of fluidity, a mobility enhanced by the worldwide wave of deregulation unleashed in the 1980s and the introduction of telecommunication networks. Such systems give banks, securities, insurance firms and back offices markedly greater freedom over their locational choices. In dramatically reducing the circulation time of capital, telecommunications have linked far-flung places together through networks in which billions of dollars move instantaneously across the globe, creating a geography without transport costs. There can be no doubt that this process has real consequences for places, as attested by the current status of cities such as London, New York, Tokyo and Singapore and the Cayman Islands. Generally, such processes tend to concentrate skilled, high value-added services, e.g. in global cities, while dispersing unskilled, low value-added services such as back offices to Third World locations.

In short, it is vital to note that, contrary to early, simplistic expectations that telecommunications would 'eliminate space', rendering geography meaningless through the effortless conquest of distance, such systems in fact produce new rounds of unevenness, forming new geographies that are imposed upon the relics of the past. Telecommunications simultaneously reflect and transform the topologies of capitalism, creating and rapidly recreating nested hierarchies of spaces technically articulated in the architec-

ture of computer networks. Indeed, far from eliminating variations among places, such systems permit the exploitation of differences between areas with renewed ferocity. As Swyngedouw (1989) noted, the emergence of hyperspaces does not entail the obliteration of local uniqueness, only its reconfiguration. That the geography engendered by this process was unforeseen a decade ago hardly needs restating; that the future will hold an equally unexpected, even bizarre, set of outcomes is equally likely.

References

AKWULE, R. (1992) *Global Telecommunications: The Technology, Administration, and Policies*. Boston: Focal Press.

BLAZAR, W. (1985) Telecommunications: harnessing it for development, *Economic Development Commentary*, 9, pp. 8–11.

BROAD, W. (1993) Doing science on the network: a long way from Gutenberg, *New York Times*, 18 May, B5.

BUCHNER, B. (1988) Social control and the diffusion of modern telecommunications technologies: a cross-national study, *American Sociological Review*, 53, pp. 446–453.

BUDD, L. and WHIMSTER, S. (Eds) (1992) *Global Finance and Urban Living: A Study of Metropolitan Change*. London: Pergamon.

BURSTYN, H. (1986) Teleports: at the crossroads. *High Technology*, 6(5), pp. 28–31.

CASTELLS, M. (1989) *The Informational City*. Oxford: Basil Blackwell.

COFFEY, W. and BAILLY, A. (1991) Producer services and flexible production: an exploratory analysis, *Growth and Change*, 22, pp. 95–117.

COOKE, K. and LEHRER, D. (1993) The Internet: the whole world is talking, *The Nation*, 257, pp. 60–63.

CORBRIDGE S. (1984) Crisis, what crisis? Monetarism, Brandt II and the geopolitics of debt, *Political Geography Quarterly*, 3, pp. 331–345.

COREY, K. (1991) The role of information technology in the planning and development of Singapore, in: B. BRUNN and T. LEINBACH (Eds) *Collapsing Space and Time*, pp. 217–231. London: HarperCollins.

CYBRIWSKY, R. (1991) *Tokyo: The Changing Profile of an Urban Giant*. Boston: G.K. Hall and Co.

DICKEN, P. (1987) A tale of two NICs: Hong Kong and Singapore at the crossroads, *Geoforum*, 18, pp. 151–164.

DICKEN, P. (1992) *Global Shift: The Internationalization of Economic Activity*, 2nd edn. New York: Guilford Press.

FAR EASTERN ECONOMIC REVIEW (1987) Japan banking and finance, 9 April, pp. 47–110.

GARNHAM, N. (1990) *Capitalism and Communication: Global Culture and the Economics of Information*. Beverly Hills: Sage.

GILLESPIE, A. and WILLIAMS, H. (1988) Telecommunications and the reconstruction of comparative advantage, *Environment and Planning A*, 20, pp. 1311–1321.

GODDARD, J. and GILLESPIE, A. (1986) *Advanced Telecommunications and Regional Development*. Newcastle-upon-Tyne: Centre for Urban and Regional Development Studies.

GRAHAM, J. *ET AL.*(1988) Restructuring in U.S. manufacturing: the decline of monopoly capitalism, *Annals of the Association of American Geographers*, 78, pp. 473–490.

GULDMANN, J. (1990) Economies of scale and density in local telephone networks, *Regional Science and Urban Economics*, 20, pp. 521–533.

HALL, P. and PRESTON, P. (1988) *The Carrier Wave: New Information Technology and the Geography of Innovation, 1846–2003*. London: Unwin Hyman.

HANNEMAN, G. (1987a) The development of teleports, *Satellite Communications*, March, pp. 14–22.

HANNEMAN, G. (1987b) Teleport business, *Satellite Communications*, April, pp. 23–26.

HANNEMAN, G. (1987c) Teleports: the global outlook, *Satellite Communications*, May, pp. 29–33.

HARVEY, D. (1989) *The Condition of Postmodernity*. Oxford: Basil Blackwell.

HARVEY, D. (1990) Between space and time: reflections on the geographical imagination, *Annals of the Association of American Geographers*, 80, pp. 418–434.

HEPWORTH, M. (1986) The geography of technological change in the information economy, *Regional Studies*, 20, pp. 407–424.

HEPWORTH, M. (1990) *Geography of the Information Economy*. London: Guildford Press.

Insight. (1988) Juggling trillions on a wire: is electronic money safe? 15 February, pp. 38–40.

JUSSAWALLA, M. and CHEAH, C. (1983) Towards an information economy: the case of Singapore, *Information Economics and Policy*, 1. pp. 161–176.

KAKABADSE, M. (1987) *International Trade in Services: Prospects for Liberalisation in the 1990s*. London: Croom Helm.

LANGDALE, J. (1985) Electronic funds transfer and the internationalisation of the banking and finance industry, *Geoforum*, 16, pp. 1–13.

LANGDALE, J. (1989) The geography of international business telecommunications: the role

of leased networks, *Annals of the Association of American Geographers*, 79, pp. 501–522.

LEWIS, P. (1994) A boom for on-line services, *New York Times*, 12 July, C1.

LIPMAN, A., SUGARMAN, A. and CUSHMAN, R. (1986) *Teleports and the Intelligent City*. Homewood, IL: Dow Jones.

LOHR, S. (1988) The growth of the global office, *New York Times*, 18 October, D1.

MARKOFF, J. (1993) Traffic jams already on the information highway, *New York Times*, 3 November, p. 1, C7.

MARSHALL, M. (1987) *Long Waves of Regional Development*. London: Macmillan.

MASAI, Y. (1989) Greater Tokyo as a global city, in: R. KNIGHT and G. GAPPERT (Eds) *Cities in a Global Society*. Newbury Park, CA: Sage.

MOLLENKOPF, J. and CASTELLS, M. (Eds) (1992) *Dual City: Restructuring New York*. New York: Russell Sage Foundation.

MOSS, M. (1987a) Telecommunications, world cities and urban policy. *Urban Studies*, 24, pp. 534–546.

MOSS, M. (1987b) Telecommunications and international financial centres, in: J. BROTCHIE, P. HALL and P. NEWTON (Eds) *The Spatial Impact of Technological Change*. London: Croom Helm.

MOSS, M. and DUNAU, A. (1986) Offices, information technology, and locational trends, in: J. BLACK, K. ROARK and L. SCHWARTZ (Eds) *The Changing Office Workplace*, pp. 171–182. Washington, DC: Urban Land Institute.

MUNGO, P. and CLOUGH, B. (1993) *Approaching Zero: The Extraordinary Underworld of Hackers, Phreakers, Virus Writers, and Keyboard Criminals*. New York: Random House.

NAKAMURA, H. and WHITE, J. (1988) Tokyo, in: M. DOGAN and J. KASARDA (Eds) *The Metropolitan Era, Volume 2: Mega-Cities*. Newbury Park, CA: Sage.

NELSON, K. (1986) Labor demand, labor supply and the suburbanization of low-wage office work. in: A. SCOTT and M. STORPER (Eds) *Production, Work, Territory*. Boston: Allen Unwin.

NICOL, L. (1985) Communications technology: economic and spatial impacts, in: M. CASTELLS (Ed.) *High Technology, Space, and Society*, pp. 191–209. Beverly Hills, CA: Sage.

NOYELLE, T. and DUTKA, A. (1988) *International Trade in Business Services*. Cambridge, MA: Ballinger.

OFFICE OF TECHNOLOGY ASSESSMENT (1993) *Automation of America's Offices*. Washington, DC: US Government Printing Office.

PECCHIOLI, R. (1983) *The Internationalization of Banking: The Policy Issues*, Paris: OECD.

POSTER, M. (1990) *The Mode of Information: Poststructuralism and Social Context*. Chicago: University of Chicago Press.

QUINN, J., BARUCH, J. and PAQUETTE, P. (1987) Technology in services. *Scientific American*, 257(6), pp. 50–58.

RIMMER, P. (1991) Exporting cities to the western Pacific Rim: the art of the Japanese package, in: J. BROTCHIE, M. BATTY, P. HALL and P. NEWTON (Eds) *Cities of the 21st Century*. Melbourne: Longman Cheshire.

ROBERTS, S. (1994) Fictitious capital, fictitious spaces: the geography of offshore financial flows, in: S. CORBRIDGE, R. MARTIN and N. THRIFT (Eds) *Money Power Space*. Oxford: Basil Blackwell.

RODRIGUEZ, N. and FEAGIN, J. (1986) Urban specialization in the world-system, *Urban Affairs Quarterly*, 22, pp. 187–219.

ROHLFS, J. (1974) A theory of interdependent demand for a communications service, *Bell Journal of Economics and Management Science*, 5, pp. 13–37.

SASSEN, S. (1991) *The Global City: New York, London, Tokyo*. Princeton, NJ: Princeton University Press.

SAUNDERS, R., WARFORD, J. and WELLENIUS, B. (1983) *Telecommunications and Economic Development*. Baltimore: Johns Hopkins University Press.

SCANLON, R. (1989) New York City as global capital in the 1980s, in: R. KNIGHT and G. GAPPERT (Eds) *Cities in a Global Society*. Newbury Park, CA: Sage.

SCHILLER, H. (1993) 'The information highway': public way or private road? *The Nation*, 257, pp. 64–65.

SCOTT, A.J. (1988) *New Industrial Spaces*. London: Pion.

SHEFTER, M. (1993) *Capital of the American Century: The National and International Influence of New York City*. New York: Russell Sage Foundation.

STEPHENS, G. (1987) What can business get from teleports? *Satellite Communications*, March, pp. 18–19.

STRANGE, S. (1986) *Casino Capitalism*. Oxford: Basil Blackwell.

SWYNGEDOUW, E. (1989) The heart of the place: the resurrection of locality in an age of hyperspace, *Geografiska Annaler*, 71, pp. 31–42.

TARDOS, A. (1991) Problems of the financial information system in Hungary, *Acta Oeconomica*, 43, pp. 149–166.

THRIFT, N. (1987) The fixers: the urban geography of international commercial capital, in: J. HENDERSON and M. CASTELLS (Eds) *Global Restructuring and Territorial Development*. Beverly Hills: Sage Publications.

TOKYO METROPOLITAN GOVERNMENT PLANNING DEPARTMENT (1993) *Tokyo Teleport*. Tokyo: Tokyo Metropolitan Government Information Centre.

VOGEL, E. (1986) Pax Nipponica? *Foreign Affairs*, 64, pp. 752–767.

WACHTEL, H. (1987) Currency without a country: the global funny money game, *The Nation*, 26 December, 245, pp. 784–790.

WALKER, R. (1985) Is there a service economy? The changing capitalist division of labor, *Science and Society*, Spring, pp. 42–83.

WALTER, I. (1988) *Global Competition in Financial Services: Market Structure, Protection, and Trade Liberalization*. Cambridge, MA: Ballinger.

WALTER, I. (1989) *Secret Money*. London: Unwin Hyman.

WARF, B. (1989) Telecommunications and the globalization of financial services, *Professional Geographer*, 41, pp. 257–271.

WARF, B. (1991) The internationalization of New York services, in: P. DANIELS (Ed.) *Services and Metropolitan Development: International Perspectives*, pp. 245–264. London: Routledge.

WARF, B. (1993) Back office dispersal: implications for urban development, *Economic Development Commentary*, 16, pp. 11–16.

WARF, B. (forthcoming) Information services in the Dominican Republic, *Yearbook of the Association of Latin American Geographers*.

WEIS, A. (1992) Commercialization of the Internet, *Electronic Networking*, 2(3), pp. 7–16.

WHITLOCK, E. and NYEVRIKEL, E. (1992) The evolution of Hungarian telecommunications. *Telecommunications Policy*, pp. 249–258.

WILSON, M. (1991) *Offshore relocation of producer services: the Irish back office*. Paper presented at the *Annual Meeting of the Association of American Geographers*, Miami.

WOOD, P. (1991) Flexible accumulation and the rise of business services, *Transactions of the Institute of British Geographers*, 16, pp. 160–172.