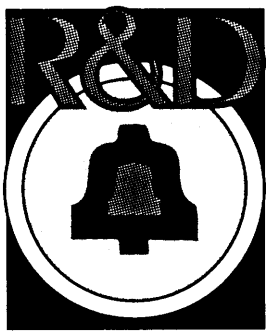
International Investment and Domestic Infrastructure

CHAPTER 9



Some analysts believe that there is a decline in U.S. infrastructure quality relative to that in other advanced nations.

A MAJOR PUBLIC POLICY DEBATE is shaping up over the modernization of the U.S. telecommunications infrastructure. The debate is framed primarily in terms of domestic technology policy. but is closely linked to the subject of international teleconmmnications and trade in services. The linkage is in two prevalent assertions:

- A highly advanced domestic communications infrastructure may be necessary to sustain long-term competitiveness in world markets, but
- excessive investment overseas by U.S. telecommunications firms could lead to ''disinvestment' in domestic communications networks, or in research and development (R&D).

The latter concern has been expressed by some State regulators, public interest group representatives, and independent analysts, who say the drain of capital from local and regional operating companies for investment in overseas ventures is causing a decline in telephone industry investment in domestic networks. Some believe there is already a decline in infrastructure quality compared with that in other advanced nations.

The objection to overseas expansion is not to international trade in services, which is almost invariably seen in positive terms, but to the preponderance of overseas direct investment through subsidiaries and joint ventures. These investments by carriers are sometimes assumed to compete for capital and for management attention with domestic infrastructure modernization.

On the other side, some state regulators and consumer group representatives object to proposed large investments in modernizing public networks, on the grounds that residential and small business subscribers will find themselves paying for capabilities and services that benefit only large corporations.

The term 'telecommunications infrastructure' has become popular to denote the facilities, networks, and equipment used to deliver telecommunications services; it is often extended to include organizations and people. The term acknowledges that telecommunications is not merely a set of tradeable services but also a basic part of the structure of industrial societies that is essential to social cohesion, governance, economic viability and equity. Even in purely economic terms, many people hold that "investments made in an advanced telecommunications infrastructure are justified on the basis of benefits that are realized at the macroeconomics level, over and above any direct benefits to individual enterprises. ' On the other hand, critics have warned that the use of the term, especially by U.S. carriers, is sometimes ''self-serving and instrumental because it is intended to suggest that the networks are imbued with the public interest and, thereby, merit direct public investment and regulatory relief.[2]

Within the scope of this report on U.S. telecommunications firms in European markets, there is no room to address the complex arguments and counterarguments about how

[1] Bruce L. Egan and Steven S. Wildman, "Investing in the Telecommunications Infrastructure: Economics and Policy Considerations," Institute for Information Studies, Annual Review, *A National /r? formation Network-Changing Our Lives in the 21st Century, 1992,* p. 29.

[2] Oscar H. Gandy, Jr., "Infrastructure: A Chaotic Disturbance in the Policy Discourse," Institute for Information Studies, op. cit., footnote 1, pp. ix ff.

much domestic infrastructure modernization should occur and who should pay for it, or whether the United States should construct a "National Information Infrastructure' or "electronic superhighway, ' This chapter will, however, address the narrower question that directly relates international trade in telecommunications services to this domestic telecommunications policy issue:

> *Is there evidence that growing overseas investment by regulated U.S. telecommunications operators is resulting in a significant decline in domestic investment, either in modernizing of physical facilities or in research and development?*

International comparisons

Two kinds of investment must be considered: investment in infrastructure modernization, and longer-term industry investment in R&D. According to many researchers on innovation and competitiveness:

> *Facilities for basic research. . . can be considered as an increasingly important part of the infrastructure for downstream technological and production activities.*[3]

Infrastructure modernization

The superiority of the U.S. network was generally accepted for decades, but is now being questioned. Some analysts claim the Nation's telecommunications infrastructure is, if not deteriorating, at least no longer clearly the world's best. Robert G. Harris of the University of California at Berkeley, William Davidson of the Management Education Services Association, and Kenneth Robinson, former assistant to Chairman Alfred Sikes of the Federal Communications Commission (FCC), are among those who believe that the quality of the U.S. telecommunications infrastructure is slipping and could fall behind that in Europe.[4] Harris says:

> *[B]y the late* 1980's *the United States no longer [had] a telecommunications sector far superior to that of other nations, in the quality or extent of the network, in the range of communications or information services available through the network, or even in the underlying technological prowess.*[5]

Others suggest that the United States has already been surpassed.[6] These charges were made so frequently and strongly that the

[3] K. Pavitt, "What Makes Basic Research Economically Useful?" *Research Policy* 20, *1992,* p. 109.

[4] Robert G. Harris is Chairperson of the Business & Public Policy Group of the Walter A. Haas School of Business, University of California, Berkeley; William Davidson is a professor at the University of Southern California and President of the Management Education Services Association (MESA), a consulting group often used by RBOCs; see MESA, *Comparative Assessment of National Public Telecommunications Infrastructures*, April 1990.

[5] Robert G. Harris, "Telecommunications Services as a Strategic Industry: Implications for U.S. Public Policy," Michael A. Crew (cd.), Competition *and the Regulation 01 Utilities* (Norwell, MA: Kluwer Academic Publishers, 1991).

[6] For example, Shlomo Maital argues that "the French phone system may now be the world's best." Shlomo Maital, "The Global Telecommunications Pict ure: Is America Being Outstripped by France?" *The Brookings Review*, summer 1992, p. 41.

National Telecommunications and Information Administration (NTIA) in 1991 undertook a detailed assessment of the evidence for infrastructure deterioration.' While the study was underway, a series of service outages occurred in the summer of 1991 that involved failures of software switching and signaling; these raised further suspicions about the quality of the network.

The NTIA report concluded that the United States still holds a high ranking in international comparisons of telecommunications infrastructure. By NTIA assessment, the United States was in 1991 first in network utilization, first in network reliability, and first in fiber optics deployment and common channel signaling. It was seventh in number of lines per 100 persons, but it was exceeded only by the Nordic countries, Switzerland, Canada, and Iceland, all of which for reasons of geography, climatic, and population dispersion put especially great emphasis on access to telephone lines. The United States is far down the list in Integrated Services Digital Network (ISDN) capability, but ISDN is not necessarily a good indicator of modernization. The lower rate of ISDN deployment in United States reflects a trend toward a different philosophy of network architecture, oriented toward dispersed intelligence or computerization rather than centralization and integration (see chapter 2).

In international comparisons, the United States ranked 13th in average annual industry investment per main line during the 1980s, according to NTIA, falling behind the major European countries except for the United Kingdom.[8] However, when the expenditures were partitioned into two categories, ''expansion' and ''modernization, ' the United States ranked higher on industry investment in modernization.[9]

The NTIA report concluded that ". . .thc United States is a nation with an advanced telecommunications infrastructure, a very high access-line density, a robust level of telephone usage, and a heavy emphasis on modernization. [10] It noted, however, that ''other countries may be planning to deploy several new technologies, such as digital switching and Signaling System 7 (SS7), more rapidly than companies in the United States.' NTIA then advocated increased competition in local exchange markets and the elimination of government-imposed barriers to competition such as those in the Modified Final Judgment (MFJ) and cross-ownership provision of the cable-telephone company. (See chapter 1, box 1 -A,)

There was, according to William F. Maher, the NTIA Associate Administrator responsible for the report, ''a political bias toward a competitive solution' to the infrastructure issue in the NTIA report. In a statement

There may have been a "political bias toward the competitive solution" to infrastructure issues.

[7] U.S. Department of Commerce, National Telecommunications and Information Administration: *The NT/A /infrastructure Report: Telecommunications in the Age of Information*, October 1991.

[8] NTIA, op. cit., footnote 7, pp. 153 ff.

[9] NTIA used several measures for investment in modernization, making adjustments for factors such as accounting treatment for labor costs and varying patterns of responsibility for consumer premises equipment. In t he several resulting analyses, the United States ranked from first to sixth, either ahead of or close to the major European countries.

[10] NTIA, op. cit., footnote 7, Executive Summary, pp. i-ii.

provided to OTA by Maher in 1992,[11] he acknowledged that prior to its release, the NTIA study was thoroughly examined to ensure that it was fully congruent with prevailing deregulatory policy. Thus the report recommendations and international comparisons should be accepted with at least a grain of salt.

Maher said that the NTIA data, although ''limited,"

> *. . . appeared to contain indications that a straight competitive market approach may not be the most efffective way to develop a superior telecommunications infrastructrure, e.g. . . . The U. S., the world's most competitive country, is being eclipsed in key areas of technology (e.g.,* SS7 *and digital switching) by countries that have retained a single supplier telecommunications environment (e.g., France). . . ."*

The NTIA infrastructure report itself cautions that other countries are rapidly catching up, especially those countries in which investments for network modernization are supported by government policy. The United Kingdom, France, Japan, and Singapore have all made telecommunications modernization a high priority,

Most international comparisons look only at investments by the public telephone operators (PTOs) for public networks, but in the United States, more than in any other country, there is also much corporate investment in private network technology. Moreover, the figures for the United States exclude customer premises equipment, while those for foreign countries arc likely to include functionally-comparable equipment belonging to the PTOs. The FCC says that annual infrastructure investment in the United States totals more that $50 billion, which is split almost evenly between network equipment and customer premises equipment. [12]

Thus, while it is widely accepted that investment by U.S. carriers in physical infrastructure is lower than such investment by many foreign PTOs, both as a percentage of revenues and a percentage of net profits, it is difficult to determine how large the gap really is, what causes it, and whether all or any part of it is related to overseas investment.

***It** is **difficult to tell how large the gap** in investment is, or what causes it.*

*International **R&D** expenditures*

Successful competition in international telecommunications markets may in the long run depend on continuing investment in R&D:

> Where *innovation is an important aspect of competition, the ability of a firm to survive depends on the effectiveness of its research and development laboratories [and] on its ability to exploit its innovations and protect them, or to quickly match anything its competitors may do.*[13]

[11] Maher made these statements personally in an informal meeting at George Washington University, and himself distributed the typed version, which does not however bear his name but that of J.C. Barry, Regulatory Research, and the date Nov. 12, 1991.

[12] Statement of Robert Pepper, Chief, Office of Plans and Policy, FCC, in Hearings on National "Technology Policy, before the Subcommittee on Technology, Environment, and Aviation of the House Committee on Science, Space, and Technology, Mar. 23, 1993.

13 Richard Nelson, *Understanding Technical Change as an Evolutionary Process (New* York: Elsevier Science Publishers, 1987), p. 6.

Table 9-1. R&D Expenditure Comparison: Bell Operating Companies vs. Domestic and Foreign Equipment Vendors, Fiscal Years 1985-90

R&D expenditures ($millions)

Company	1985	1986	1987	1988	1989	1990	6 yr. total	6 yr. avg.
BOC composite	s 91	**$ 112**	$ 126	$ 306	$ 325	$ 319	$ 1,279	$ 213
Alcatel	**200**	**237**	316	330	297	386	1,766	294
AT&T	2,228	**2,278**	2,453	2,572	2,652	2,433	14,616	2,436
Ericsson	314	**424**	507	601	673	803	3,322	554
Fujitsu	530	**884**	1,141	1,529	1,862	1,891	7,837	1,306
NEC	1,146	**1,841**	2,634	3,482	3,665	3,496	16,264	2,711
Northern Telecom	430	**475**	588	711	730	774	3,708	618
Siemens	1,561	**2,303**	3,443	3,913	3,629	4,123	18,972	3,162

R&D expenditures as a percentage of revenue

Company	1985	1986	1987	1988	1989	1990	6 yr. avg
BOC composite	0.1 %	0.2%	0,2%	0.4%	**0.4%**	0.4%	0.3%
Alcatel	16.7	16,0	18,4	19.5	**20.2**	22.9	18.3
AT&T	6.5	6.7	7,3	7.3	**7.3**	6.5	6.9
Ericsson	8.6	9.9	9.9	11.3	**11.0**	10.7	10.4
Fujitsu	8.5	9.3	9.3	9.3	**10,3**	11.7	10.0
NEC	12.7	14.0	15.7	15.9	**15.8**	16.1	15.4
Northern Telecom	10.0	10,7	12.0	13.1	**12.0**	11.4	11.6
Siemens	8.8	11.5	12.1	10.9	**11.2**	11.0	11.0

SOURCE ROBERT G HARRIS, "RESEARCH AND DEVELOPMENT EXPENDITURES BY THE BELL OPERATING COMPANIES A COMPARATIVE ASSESSMENT," 23RD ANNUAL CONFERENCE, INSTITUTE OF PUBLIC UTILITIES, MICHIGAN STATE UNIVERSITY, DEC. 9, 1991

Investment in R&D by telecomnmunications companies is said by many experts (even within the industry) to be lower in the United States than in Europe and Japan, both for equipment manufacturers and for services companies. (See table 9-1.)[14] AT&T's annual expenditures for R&D from 1985 through 1990 averaged about 6.9 percent of revenues: those for European equipment manufacturers were all higher, ranging from 10 to 18 percent. However, AT&T is a carrier as well as an equipment manufacturer, a factor that would be expected to dilute its R&D expenditure relative to purely technology-development firms.

Other analysts have compared the R&D expenditures of the three largest U.S. firms manufacturing telecommunications equipment (AT&T, GTE, and Rockwell) with that of the five largest European manufacturers for the years 1985 through 1990. U.S. spending on R&D increased about 2 percent in these years (i.e., was essentially flat), while the Europeans' R&D investments

[14] Robert G. Harris, "R&D Expenditures by the Bell Operating Companies: A Comparative Assessment," paper presented to the 23rd Annual Conference of the Institute of Public Utilities of the Michigan State University, in Williamsburg, VA, Dec. 9, 1991. Professor Harris' data were gathered in an audit performed on behalf of the National Association of Regulatory Utility Comm issioners.

Table 9-2. R&D Expenditure **Comparison: Bell** *Operating Companies vs. Foreign Telecommunications Companies, Fiscal Years 1985-90*

R&D expenditures ($millions)

Company	1985	1986	1987	1988	1989	1990	6 yr. total	6 yr. avg.
BOC composite	$91	$112	$ 126	$ 306	$ 325	$ 319	$1,279	$ 213
British Telecom	226	239	305	368	361	376	1,875	313
France Telecom	298	431	449	730	595	723	3,226	538
NTT	507	767	1,024	1,461	1,672	1,568	6,999	1,167

R&D expenditures as a percentage of revenue

Company	1985	1986	1987	1988	1989	1990	6 yr. total
BOC composite	0.1 %	0.2%	0.2%	0.5%	0.4%	0.4%	0.3%
British Telecom	2.4	1.9	2,0	1.9	1.9	1.9	2.0
France Telecom	3.3	3.4	2.8	4.6	3.5 [4]	4.0	3.6
NTT	2.7	2.7	2.8	3.2	3.8	4.1	3.3

SOURCE ROBERT G HARRIS, "RESEARCH AND DEVELOPMENT EXPENDITURES BY THE BELL OPERATING COMPANIES A COMPARATIVE ASSESSMENT," 23RD ANNUAL CONFERENCE, INSTITUTE OF PUBLIC UTILITIES, MICHIGAN STATE UNIVERSITY, DEC. 9, 1991

increased by 17 percent.'[15] The annual average number of U.S. patents granted to the U.S. companies decreased by 3.2 percent during this period, while the number granted to the European companies rose by 11 percent. overseas expansion by U.S. carriers began growing significantly during this period (about 1987-88), but the period also saw a serious recession begin.

Table 9-1 includes for comparison the R&D investments of the Bell operating companies (BOCs), which are only 0.3 percent of revenue annually. This is again a misleading comparison because the BOCs are precluded from equipment manufacturing, which is generally more research-intensive than services. Nevertheless, investment in R&D is very likely depressed by the regulatory separation of manufacturing and services.1'

Table 9-2 compares R&D expenditures by the regional Bell holding companies (RBHCs) (including support for their shared research facility, Bellcore) with expenditures by BT and France Telecom, a more suitable comparison because those firms are also carriers that do not manufacture equipment and serve populations and geographical areas comparable to those of some RBHCs. The expenditures for R&D, as percentage of income, are respectively 7 to 12 times greater for the European PTOs than for the RBHCs. Here also there are caveats. In Europe the trend is toward building intelligence into the network, whereas in the United States the trend is toward placing intelligence at the periphery of networks, including more of it in advanced terminal or customer-premise equipment. This affects where investment in R&D occurs and by whom it is made.

15 Robert T. Blau, "IS Technology the Key to Competing in Global Telecommunications Markets?" *Technology in Transition,* 1993 BellSouth Environmental Scan, pp. 44-51. R&D expenditures by Japan's NTT increased 19 percent in the same period, and its number of U.S. patents grew by 11 percent.

16 Robert G. Harris, op. cit., footnote 5.

Table 9-3. R&D Expenditure on Telecommunications in Selected Countries, 1987 ($ billions)

	U.S.	Japan	Germany	France	U.K.	Italy	Sweden	South Korea	Netherlands	Spain
R&D expenditure on telecommunications	13	4.7	2.5	2.1	2.1	0.5	0.48	0.41	0.2	0.11
Military sector	5	0	0.2a	1.0	0.7	na	O.1	[a] na	O[a]	na
Civil sector	8	4.7	2.3	1.1	1.4	na	0.38	na	**0.2**	**na**
R&D expenditure on telecommunications as percentage of total national R&D expenditure	10	10	11	13	13	6	14	9	5	5

NOTES Estimates Conversion factor of national currencies with purchasing power parity in U S dollars

[a] Approximation.

SOURCE HARIOLF GRUPP AND THOMAS SCHNORING, "RESEARCH AND DEVELOPMENT IN TELECOMMUNICATIONS NATIONAL SYSTEMS UNDER PRESSURE," *TELECOMMUNICATIONS POLICY*, JANUARY/FEBRUARY 1991, PP 46-65.

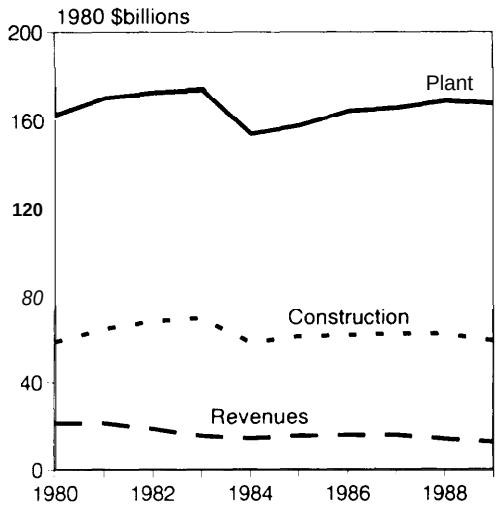
According to this reasoning, European expenditures attributed to industry research on telecommunications equipment probably include much research that in the United States is conducted by computer manufacturers.

Since the PTOs are largely state-owned, they may be a channel for national R&D support that in the United States would be directed at military research or at the national laboratories. Hariolf Grupp and Thomas Schnoring, German researchers, compared 10 countries in terms of R&D expenditures on telecommunications in 1987, and concluded that levels of spending reflected the size of national economies (see table 9-3.) They ranked the United States first ($13 bill ion), followed by Japan ($4.7 billion) and the four large European countries (Germany, $2.5 billion; France, $2.1 billion; the United Kingdom, $2.1 billion: and Italy, $0.5 billion). The conclusions of Grupp and Schnoring are thus at odds with most other analysts, probably because they include all sources of R&D funding, including military spending.[17] Nearly all nonmilitary R&D spending in the United States comes from the carriers, the German analysts claim, compared with about 60 percent in France and only 7 percent in Germany. In the United States, much government funding of R&D has been carried out through the Department of Defense,[18] while in other countries it may come from nonmilitary agencies; so this comparison may reflect national differences in public administration rather than differences in government/industry research funding,

[17] Military R&Don telecommunications, according to Gruppand Schnoring, has significant spillover benefits for civilian telecommunications. Hariolf Grupp and Thomas Schnoring, "Research and Development in Telecommunications: National Systems Under Pressure," *Telecommunications Policy,* January/February 1991, pp. 46-65. See also Thomas Schnoring, "European Telecommunications R&D Systems m Transition," Wissenschaftliches Institut fur Kommunikationsdienste GmbH, Bad Honnef, Germany, December 1992.

[18] Federal Government funding supports nearly half of the communications R&D performed by Industry, according to the National Science Foundation, *National Patterns 01 R&D Resources: 1992*, NSF 92-220, October 1992, table 3, p. 19.

Figure 9-1. Local Telecommunications Exchange Carrier Plant and Revenues, 1980-89



SOURCE: U.S. TELEPHONE ASSOCIATION.

Most of the available international comparisons are highly questionable on several grounds, including differences in industry structure, regulatory requirements, and accounting procedures. What is included in "R&D expenditures" and the meaning of "net income' may differ.

The question of domestic disinvestment

Assuming that investment by U.S. telecommunications firms in physical modernization and in R&D is below that in Europe, this still does not address the narrower questions of whether it is declining, and specifically whether it declined after overseas expansion became common and as a result of the increasing overseas investment.

Trends in infrastructure modernization

According to the U.S. Telephone Association, the value of U.S. carriers' current plant grew only 3 percent from 1980 to 1989 (in constant 1980 dollars), and the value of annual construction appears to have decreased strikingly between 1980 and 1989. (See figure 9-1.) In 1980 dollars, it decreased 40 percent from 1980 ($21.2 billion) to 1989 ($12.6 billion). In 8 of the 9 years, construction declined from the previous year or was stable (increasing 1 percent or less).

FCC figures for 'reporting local carriers indicate that from 1985 to 1989, the value of gross plant grew by 6 percent (in constant dollars) but it did not increase from 1987 to 1989.[19] (See figure 9-2.) Each year from 1986 through 1989, the value of annual construction declined from 2 to 10 percent over the preceding year, from $15, 1 billion in 1985 to $12.3 billion in 1989, in 1980 dollars. (Annual revenues also declined by 3 percent in constant dollars in the same period.) Construction increased slightly in 1990 and 1991, as did revenues. During the 4 years 1988-91 (the only years for which data is available), the value of gross plant for the seven RBOCs declined just over 3 percent in constant dollars; the value of annual construction was steady.[20] These figures include both expansion and modernization expenditures.

Interpreting these trends is complicated, however, by the fact that the cost of computer and telecommunications equipment (e.g., fiber optics) was decreasing during

[19] FCC figures are for reporting carriers only, i.e., all regulated local exchange carriers. In 1984 RBHCs/RBOCs were separated from AT&T, and those figures may not be comparable to later figures.

20 FCC *Statistics of Common Carriers*, 1988-89, *1989-90, 1990-91, 1991-92,* table 2-7, each volume.

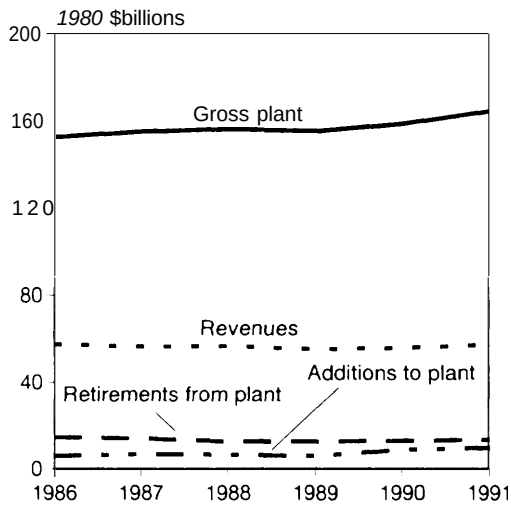
these years, The way in which several factors--cost trends, divestiture and separation of equipment and services provision, and overseas investment—interacted rides conclusions on the basis of this evidence questionable. A decade or less, in which there were several major disruptions, does not provide reliable trend data. Further, the numbers are themselves suspect because of several industrywide changes in accounting procedures promulgated by the Financial Accounting Standards Board.[21]

Trends in research and development

Expenditures for research, development, and engineering are also a long-range investment in infrastructure modernization. As noted by political scientist John Zysman:

> *. . . [C]ertain industries may be more important than others because they generate benefits for the rest of the economy, and government policies to promote or protect them can improve welfare by fostering these spillover effects. High-technologogy industries are likely to generate positive externalities because of the knowledge generated by their research and development activities, and because the benefits of this know'ledge cannot be completely appropriated by the private agents who pay the costs for the generation of such knowledge.* [22]

Telecommunications is among the industries that have generated positive social externalities from R&D; it can be shown that advances in telecommunications systems and services have benefited most sectors of American life and society, have been essential to national security, and have supported the rise of major industries. Professor of business Robert C. Harris says that R&D expenditures in leading-edge technologies such as telecommunications equipment and services generate tremendous positive spillovers that accrue to those who use and those who supply the product or process innovations that flow from R& D."[23] But the recent status and future prospects for telecommunications R&D is obscured, for public poli-



SOURCE: FEDERAL COMMUNICATIONS COMMISSION.

Figure 9-2. Local Telecommunications Exchange Carrier Gross Plant and Revenues, 1984-91

2 The Financial Accounting Standards Board (FASB) is a nongovernmental entity authorized by the U.S. Securities and Exchanges Commission to set financial accounting and reporting standards for business organizations for which stocks are publicly traded. It made changes in accounting procedures for telecommunications carriers m 1982, 1986, 1987, and 1989 (FASB Statements 71, 86, 87, 89). This Introduces discontinuities in time-series data. Information courtesy of Mark Card In, FASB.

22 John Zysman, "Trade, Technology, and National Competition," *International Journal of Technology Management,* vol. 7, No. 1-3, 1992, p. 169.

23 Robert G. Harris, op. cit., footnote 14, p. 2.

cymakers, by a dearth of reliable data. As pointed out in chapter 8, divestiture and deregulation together with longstanding government policy toward industry data collection have resulted in deficiencies in the information available to policy makers.

The Bureau of the Census conducts an annual Survey of Industrial Research and Development on behalf of the National Science Foundation (NSF) .24 Individual corporate responses are protected by law and only highly aggregated data are available to policy makers and the public; the way categories are defined makes it impossible to get a comprehensive value that includes all telecommunications R&D,[25] Telephone operating companies with revenues over $100 million must report research expenditures annually to the FCC; but this data is available only since 1988, and it covers only regulated common carriers, including the RBOCs.[26] The research performed or funded by the parent RBHCs on nonregulatcd services and technologies (such as cellular communications), including RBHCs' support for Bellcore, is not reported. Financial statements that the RHOCs make to the Securities and Exchanges Commission (Form I Ok) unanimously list R&D expenditures as "N.A." (nonavailable).

Attempts to identify trend lines in research expenditures by major carriers are further confused by the lack of consistent time-series data resulting from the many discontinuities: divestiture and reorganization, changes in accounting procedures, and acquisitions. *7 The implications of the observations reported below, therefore, contain significant uncertainties and can be considered as indicators only.

The NSF reports based on Bureau of Census data indicate that R&D performed by U.S. telecommunications equipment manufacturers, including AT&T, was 117 percent higher in 1985 than in 1980, but had increased only another 10 percent by 1990. For comparison, R&D performed by all manufacturers was only 89 percent higher in

24 A "controlled sample" of enterprises is designed to include all large companies known to be "major performers of R& D," according to analysts at the Bureau of the Census. A long detailed questionnaire is used in odd years and a shorter form in even years. See National Science Foundation, Surveys of Science Resources Series (latest edition, *Research and Development in Industry: 1989*, NSF 92-307), and *National Patterns of R&D Resources: 1992*, NSF-930, October 1992, which covers government and university R&D performance and expenditures as well as industry performance and expenditures.

25 The annual dollar value of R&D performed by telecommunicate ions equipment manufacturers is reported. This would include AT&T, since company identif icat ion is by standard industrial classif ication code. Closely related R&D on telecommunicate ions performed by computer manufacturers is in a different category that aggregates all computer R&D, and telecommunications services companies are lumped with construction, engineering, and all other services providers in the single category of "nonmanufacturing companies."

26 The data is published annually in the FCC's *Statistics of Common Carriers.* R&D expenditures were not reported prior to 1988, when a new FCC reporting rule was implemented, according to the FCC's Industry Analysis Division.

27 Research expenditures are not specifically reported to the Securities and Exchanges Commission by telecommunications companies, and the chief source of information about them are the companies' annual reports and "Form Ms" filed with the FCC. However, the FCC doubts such figures are fully comparable across companies. (Discussions wit h Industry Analysis Section, FCC). See chapter 8 for a discussion of t he inadequacy of data for policy analysis.

1985 than in 1980 but increased 24 percent from 1985 to 1990.

Information supplied by AT&T indicates that in constant dollars, AT&T's annual research expenditures (chiefly for Bell Labs) have fluctuated slightly from year to year, but essential y remained flat from divestiture in 1984 through 1991 (see table 9-4). They increased in constant dollars about 2 percent from 1987 through 1991, the period of overseas expansion. In 1992 there was a significant decrease in research expenditures, about 9 percent less than 1991 in constant dollars. AT&T's comptroller attributed this in part to a real decline and in part to a ' 'bookkeeping artifact" related to the NCR acquisition. Looked at as a percentage of reported operating revenues, research expenditures have been declining since 1990. The AT&T Annual Report says that this " . . .reflects streamlined efforts for telecommunications network products and systems and a consolidation of research and development efforts for computer products and systems following the merger [with NCR]. '

The new president of Bell Labs, John S. Mayo, promised in July 1990 that he would make the institution ''. . more of a profit-minded industrial laboratory. '[28] An AT&T spokesman said that the outlook for research expenditures is to remain flat, or shrink slightly, over the next few years.[29] This, the spokesman said, is a result of competitive pressure. Although AT&T remains "deeply committed to research, ' in recent years R&D expenditures have been subjected to more critical scrutiny within the company than they were in AT&T's years as a regulated monopoly, and are often ''hotly contested' by the company's business units.

The profile of R&D expenditure is also changing. Infrastructure modernization depends heavily on software. Bell Labs has 25,000 scientists and engineers, plus 5,000 administrators and support staff, located in 29 facilities in six states; of these, approximately 4,000 have doctorates.[30] Software development is now the dominant activity—there are now more computer scientists than electrical engineers at Bell Labs. In 1992,90 percent of the budget went to "developmerit," under the control of the managers of the 20 lines of business. This allocation between development and research does not appear to have changed a great deal since divestiture, but the physics and materials

Table 9-4. AT& T Research and Development Expenditures, 1978-92

($millions) Constant $: 1987=0

Year	R&D expenditures	Constant $	% Change	Total operating revenue	R&D as % of revenue
1984	$2,188	$2,404		$33,187	6.59
1985	2,228	2,360	-1.8	34,417	6.47
1986	2,278	2,373	0.6	34,087	6.68
1987	2,453	2,453	3.4	33,768	7.26
1988	2,572	2,475	0.5	35,210	7.30
1989	2,652	2,444	1.2	36,112	7.53
1990'b	2,935	2,593	6.0	62,191	4.72
1991	3,114	2,643	1.9	63,089	4.94
1992	2,911	2,414	-8.7	64,904	4.49

a The fluctuation 1990-91 Includes the effect of software capitalization, a change in accounting procedures.
b The large jump in total operating revenue results frm inclusion, after 1989, of access charges.
SOURCE OFFICE OF TECHNOLOGY ASSESSMENT R&D EXPENDITURES AND TOTAL OPERATING REVENUE FROM AT&T ANNUAL REPORTS TO STOCKHOLDERS, 197S-92.

[28] Peter Coy, "The Man Who's Running a Nutsier-Boltsier Bell Labs," *Business Week,* Aug. 5, 1991, p. 69.

29 OTA interview with Gale Jackson, AT&T Comptroller, Mar. 10, 1993.

30 Michael Maccoby, "Transforming R&D Services at Bell Labs," *Research & Technology Management,* January/February 1992, pp. 46-47.

science laboratories within the research division are being "de-emphasized."[31]

AT&T officials say they are putting strong emphasis on making the "development" component of R&D more cost-effective, by shortening the development cycle and getting new products to market faster, and therefore the number of people in "development' is shrinking. As a result, AT&T officials say, the basic research component of the R&D expenditure is probably rising relative to the development component. Critics dispute this, saying that there has been a pronounced shift from the long-range "near-basic" research for which the old Bell Labs had long been famous, to much more short-range market-oriented research. To the extent that this is true, it would more likely be an indirect effect of divestiture, deregulation, and increased market competition than an effect of alternative investment overseas.

Evidence of declining investment in infrastructure and R&D is mixed.. . but investment in both is almost surely less than needed.

Bell Communications Research, Inc., commonly known as '' Bellcore," was incorporated October 20, 1983, to provide its shareholders, the RBHCs, with technical support including research, engineering, and services related to emergency preparedness and national security. Bellcore does R&D in those technical areas where its owners, the RBOCs, are not in direct competition (i.e., basic communications services). Most of its research results are available to all of the owners, but occasionally there are "private' projects.[32] It also does research for some other telephone industry clients such as Bell Canada.

Bellcore's RBHC owners provide most of the institution's revenue, sharing the cost according to a formula based on the number of access lines owned by each company. Their expenditures ranged, in 1992, from $125.9 million for Pacific Bell upto$174.8 million for Bell Atlantic,[33] Other income comes from research or services done for independent telecommunications operating companies, government, or vendors, and from licensing sales. Together, these accounted for about 18 percent of total revenue in 1992.

Bellcore's budget from its inception through the current year has grown 4.9 percent in constant dollars. (See table 9-5.) It increased by 7.5 percent in real terms in the shorter period of the RBHCs' overseas expansion, from 1987 through 1992, after having shrunk through inflation. (It is possible that some of this growth is an artifact of changes in accounting practices that occurred at about this time.) However, the proportion of Bellcore's income provided by the RBHC owners also changed in that period; RBHCs contributions grew less than 2 percent from 1987 through 1992.

George Heilmeier, president of Bellcore, has said that his aim is faster product development. He has stepped up research in information technologies such as object-oriented computing and multimedia services, and is putting less emphasis on physical sciences. Bellcore ''will move away from the

31 Peter Coy, op. cit., footnote 27, and William Sweet, "Bell Labs Reorganizes Research for More Competitive Environment," *Physics Today*, June 1991, pp. 97-102.

32 Gary H. Anthes, "Bellcore in Search of New Ideas," *Computerworld*, Feb. 25, 1991, p. 83. For example, U.S. West persuaded Bellcore to keep a project proprietary for 2 years.

33 Bellcore, 1992 Annual Report.

academic model..."[34] and its operating budget may continue to shrink over the next few years.

Several of the RBHCs also have their own R&D units, apart from Bellcore, in order to protect the proprietary nature of the R&D. The most elaborate of these is NYNEX's Science & Technology, lnc.,[35] which has 346 employees in four laboratory facilities and does research in areas such as expert systems, speech reccognition and synthesis, and wireless technology. U.S. West has a somewhat smaller Advanced Technology Group, and Southwestcm Bell also has an internal R&D staff. The R&D expenditures for- these organizations are not made public.

Year	Revenue	Deflated revenue[a]	Change	%Revenue from owners	Employees	Change
984	848,357	931,748		86	n/a	
985	864,626	916,208	-1.7	91	n/a	
986	873,930	901,702	-1.2	93	n/a	
987	909,902	909,902	0.9	93	7,652	
988	984,330	947,838	4.2	92	8,237	-7.6
989	,043,537	962,495	1.5	92	8,124	-1.4
990	,097,198	972,090	1.0	91	8,635	+6.3
991	,139,042	972,709	0.1	90	8,239	-4.6
1992	$1,180,636	$977,752	0,5%	880/0	7,208	-1 2.50/o

Real change, 1984-1992 = +4.9% real change in owners' contribution = +17.9%
Real change, 1987-1992 = +7,5% real change in owners' contribution = +1.7%

a 1987 dollars

SOURCE BE LLCORE ANNUAL REPORTS, 1984 TO 1992

Tab/e 9-5. Be//core Revenue and Employees, 1984-92

Determinants of infrastructure investment

The evidence of declining telephone industry investment, in infrastructure or in R&D, is mixed and indeterminate, but the clues are sufficient to assume that U.S. industry investment in both is almost surely less than that needed to assume the United States of continued leadership, and there are no signs that it is rising There is, at a minimum, logical justification for raising two questions:

- Will investment in infrastructure moderization decline, at least in the short term. through competition with investment opportunities overseas?
- Has R&D spending declined because of the change from a monopoly market, with protected rates of return, to highly competitive markets where the investment horizon is shorter'?

On the other hand, there are good reasons to argue that competition in domestic markets and in thc global marketplace is necessary to maintain high rates of innovation in high-tech companies.

Those who perceivec a decline in domestic investment and blame it on the rush of telecommunications carriers to take advantage of overseas investment opportunities- argue that more rapidly expanding markets in Europe offer the opportunity for highcr returns and more immediate payoff than does modernization of the domestic infrastructure. Domestic investments also may suffer, they suggest, because they must meet the inspection and challenge of state regulators. Since companies must allocatc resources among competing interests, a pool of

[34] Heilmeier, quoted in Emily Smith and Peter Coy, "Pumping up the Baby Bells' R&D Arm," *Business Week,* Aug. 5, 1991, pp. 68-70.

35 NYNEX Science & Technology began m 1985 but was Incorporated as a wholly-owned subsidiary in August 1991. It has laboratories in White Plains, NY; New York City; and Cambridge and Framington, Massachusetts.

investment capital (such as the RBHCs' retained earnings) is likely to be invested disproportionately in enterprises located in economically more favorable environments.

Since local telephone services are growing slowly, RBHCs are looking to expand their portfolios of revenue-producing services, particularly video programming. However, as monopoly providers of local telephone service, they currently face a number of constraints on the services they arc permitted to offer. and these restrictions are cited as significant disincentives for network investment.

The 1992 Economic Report of the President asserted:

> *. . . it may be regulation that is discouraging firms from investing in new infrastructure. When regulatory barriers are removed, competition and the ability of firms to reap the rewards of their success provide sufficient incen - tives to invest in commercially viable telecommunications technologies. There are firms, however, that are reluctant to invest because they cannot be assured of fully capturing all the benefits of their investments.*[36]

The most frequently cited impediment is the Modified Final Judgment,[37] which prevents the RBOCs from manufacturing telecommunications equipment and offering long-distance service, and until recently from offering information services (see chapter 4, box 4-A).[38] RBHCs claim these restrictions constitute significant disincentives for continued robust investment in the public-switched network. The removal of the MFJ restrictions, they promise, will result in new industry investments in the network—justified by their entry into promising new markets. This has been interpreted by some people to mean that they would increase domestic investments at the expense of investments overseas. That would not be necessary (telecommunications companies have very high ratings in capital markets). Nor would it be likely, given the growth opportunities projected for overseas markets (see chapters 3 and 4).

A U.S. investment analyst, assessing the risk that overseas expansion will create a capital drain on U.S. telephone operators, concludes that:

> *In most cases, this risk is minimal and has not been sufficient to warrant consideration of lower ratings for the*

[36] The Economic Report of the President, Transmitted to Congress January 1993, p. 179.

37 After the divestiture of AT&T in 1982, RBOCs were granted the exclusive franchise for local telephone service, which was widely regarded as a natural monopoly, and were kept out of lines of business deemed competitive. Fears of cross-subsidizing competitive or nonregulated markets (equipment manufacturing, long-distance service) with revenue from noncompetitive or regulated markets (i.e., local telephony) informed this policy choice.

3.The manufacturing ban continues to prevent RBOCs from making changes to the software in their switches. The prohibition on long-distance carriage prevents RBOCs from centralizing information services on a single gateway for their entire regions and instead requires that they install database and switching equipment in each local access and t ransport area (LATA). National Telecommunications and Informat ion Administration, *The NTIA Infrastructure Report: Telecommunications in the Age of Information*, U.S. Department of Commerce, October 1991, p.215. NTIA has advocated the removal of the line-of-business restrictions contained in the MFJ and the cross-ownership prohibitions on cable-telephone company accepting the BOCs' promise of deployment of new services and technology.

U.S. telephone subsidiaries. Moreover, U.S. regulatory agencies would take a dim view of any attempt to seriously weaken the financial health of the local telephone companies.[39]

In addition to the MFJ, the local telephone companies arc confronted with a tangle of other federal and state regulatory obligations. The domestic investment plans of the telephone companies are subject to the review of state public utility commissions (PUCs), whose priorities for telecommunications delelopment may differ from state to state even within an RBOC's service area. Regulators have conflicting priorities: in the absence of a competitive market environment, regulators arc responsible for curbing imprudent investments and possible overinvestment that would burden customers with unnecessary costs, and at the same time, they must assure a sufficient level of industry investment to prevent telephone service from degrading and to assure that it continues to develop and improve.

Under traditional rate-of-return regulation (the prevailing regulatory model for several decades), the carriers had an incentive to invest in facilities; some critics said it was an incentive to overinvest. After divestiture and the end of cross-subsidization of local residential rates by business and long-distance rates, regulators sought to stabilize consumer prices. Beginning in the late 1980s, more than half of the states adopted some form of "incentive regulation. " This is a modified form of rate-of-return regulation, under which the regulators set a base rate of return; earnings above that rate are allowed but must be shared between ratepayers and shareholders.[40] Regulators retain control over the price of basic residential and small business access, but give the carrier pricing flexibility on competitive services offered to large companies. The carrier has an incentive to reduce costs and thus increase earnings. [41]

Critics say that incentive regulation encourages short-term cost reduction rather than long-term investment.

Incentive regulation encourages short-term cost reductions rather than long-term investment in infrastructure and in R&D,

39 Fitch Investors Service, Inc., "U.S. Telephone Companies Seek Fortunes Overseas," 1993.

40 Joseph S. Kraemer, "Improving LEC In cent ive Regulation Plans," *Public Utilities Fortnight/y,* Feb. 1,1991.

4 The local exchange carriers are also com ing under competitive pressure to cut costs. The alternative carriers, such as Metropolitan Fiber Systems (MFS), which are setting up local area networks to serve business customers, can undercut the local carrier because they serve only high volume users with new, high-capacit y equipment and nonunion workers. (One report says that MFS can installa private line at a cost 40 percent below t hat oft heprimary carrier. Half of t he reduction wassaid to come f rom lowercompen sat ion for employees.) Ron Bohlin, Allan Roth, and David L. Wenner, "Do LECS Need Magic to Cut Costs?" Telephony, Apr. 19, 1991, p. 31.

The move by local carriers to cut costs has so far largely taken the form of reducing the workforce. Pacific Telesis, for example, has cut its workforce by 18 percent since 1984 and plans another 18 percent reduction over the next 5 years; this is a total of about 25,000 jobs out of a 1984 workforce of 77,000. There is concern that this com petitive pressure on local earners may also discourage or delay investment ininfrastructure and in R&D.

according to its critics.[42] The cost and risk of investment is shifted in part from ratepayers to shareholders. Cost reductions are easier to predict and quantify than uncertain future revenue from facilities enhancement.

Some states have recognized these problems and arc experimenting with new forms of incentive regulation. Tennessee, for example, specifies special network investment requirements and allows faster capital recovery in return for accelerated investment in infrastructure. The most ambitious plans are in Illinois, New Jersey, New York, Tennessee, and Washington. New Jersey Bell is investing $1 billion by 1999 to expand narrowband capabilities and begin installing broadband network services. Tennessee has a similar 10 year plan to achieve universal ISDN availability in urban areas.[43]

State commissions and the FCC have another handle on investment decisions through the rules for equipment depreciation. PUCs typically require of telephone companies very long depreciation schedules for net work equipment. This keeps rates low, but also slows down the replacement of old equipment with modern equipment.[44] The FCC has just proposed new incentives for local telephone companies to invest in fiber optics and computerized switches by allowing them to depreciate their investment in old equipment more rapidly. The FCC regulates interstate access charges through price caps; these set a mandated ceiling on consumer prices and, within that range, telephone companies can increase their profits (up to about 13 percent) by cutting their costs. If the rate of return exceeds 13 percent, customer charges must be lowered to return half of the surplus profit to customers. Big depreciation expenses reduce a company's reportable profits. This can mean as much as $0.50 additional profit for each additional dollar of depreciation .45

Telecommunications has become a major factor in corporate site selection, especially for corporate headquarters, airlines, financial services, and business services. States are caught in a dilemma of wanting good telecommunications to attract economic development, yet also wanting to keep their residential rates low and to reduce their intrastate long-distance rates to discourage corporate bypass.[46]

Some consumer advocates insist infrastructure modernization could be wasteful; it could benefit only RBHCs and their shareholders, and not the small businesses and

42 Bohlin, Roth, and Wenner, op. cit., footnote 40. For a counterview, see Chris Gadrowski, "Counterpoint: Don't Shackle Incentive Regulation," *Public Utilities Fortnightly,* Apr. 15, 1991. Gadrowski objects to regulators specifying inputs (investments) rather than outputs (level **and quality of services) but acknowledges that incentive regulation can create the incentive to reduce network investment unless it is coupled with penalties** for reduced service quality levels (in the form of making refunds to customers).

43 Information provided by Ronald G. Choura of the Michigan Public Service Comm ission and the Alliance for Public Technology, February 1993.

44 In *Louisiana PUC* v. *FCC,* 476 US 355 (1986), an FCC order preempting conflicting state depreciation policy was set aside.

45 "FCC Proposes Incentives for Local Phone Companies," *Telecom* Highlights *International,* Dec. 16,1992, p. 11.

46 Paul E. Teske, "State Telecommunications Policy in the 1980s," *Policy Studies Review,* spring 1992, vol. 11, No. 1, p. 118.

households who will pay a large part of the costs. Also, it could squeeze out investments that might otherwise go to smaller and more innovative companies. The alternative to network modernization, however, appears to be reliance on very fast, high capacity packet-switching services and other new technologies, often provided by alternative carriers, that will benefit very large corporate users concentrated in some urban centers, and will offer Iittle or no support for middle-sized and small businesses.

At current rates of industry investment. the domestic infrastructure may be upgraded slowly and unevenly.[47] Much more modernization will be on private networks. This at Ieast would mean that those who benefit most directly will pay. But some economists warn that corporations may not promote interconnectivity at the most desirable levels. Even large users may not by themselves generate enough traffic to justify some of the benefits that would be possible with broad access. Alternative carriers will be attracted only in cities large enough to allow several companies, or many companies, to reach economies of scale.

Conclusions

The argument that the U.S. telecommunications infrastructure is in perilous decline cannot be supported on the basis of publicly available information. Usage of the telecommunications network continues to increase and is significantly higher than in European countries. U.S. companies operating in Europe attest to the general superiority of U.S. telecommunications and information services (as discussed in chapter 5). The number of new domestic services continues to increase: the last 1() years have seen the explosion in facsimile communications, data networking, and cellular services. New players are crowding into the industry, such as cable TV companies and alternative access providers. There is vigorous competition among equipment manufacturers, many of which are small, new operations carving out niche markets. Corporations have created substantial and finely-tailored private networks that arc now being integrated with the public switched telephone network. As the NTIA infrastructure report concludes, the United States has ‘‘a well-developed, advanced infrastructure, characterized by a very high access-line density, a robust level of telephone usage, and a heavy emphasis on ‘‘modernization."[48]

Meanwhile, there is no strong public policy guiding or encouraging planning for the networks of the future. It is by no means certain that the highly competitive market that has developed in the last decade provides the incentives necessary for a level of investment--in infrastructure modernization and in R&D—that will be needed to keep the U.S. teleccommunications industry and the U.S. telecommunications infrastructure in excellent condition. Many economists say a competitive market economy does not automatically generate the optimal magnitude and allocation of R&D. [49]

The evidence is inconclusive at best as to whether industry investment in infrastructure and R&D has significantly declined in the short period (about 5 years) of overseas

There is **no** *strong* **public policy** *encouraging planning for the networks of the future.*

[47] Egan and Wildman, op. cit., footnote 1, p. 40.

[48] NTIA, op. cit., footnote 7, p. 197.

[49] Richard Nelson, op. cit., footnote 13.

BOX 9A. TELECOMMUNICATIONS INDUSTRY INVESTMENT: SOURCES OF UNCERTAINTY OR CONFUSION

Investment categories	Caveats	Examples/ explanation
Domestic:		
Infrastructure modernization and R&D expenditure	Historical discontinuities	Introduction of competition; total market includes MCI, Sprint, as well as AT&T.
	Divestiture	Separation of Bell operating companies from AT&T. Separation of services from equipment manufacturing.
	Changes in accounting and reporting procedures	Financial Standards Accounting Board changes; comparability of income and expenditure categories before and after change is reduced or uncertain.
	Acquisitions, mergers, joint ventures, sales of company components	AT&T acquisition of NCR; RBOCs entry into cellular market.
	Decreasing technological costs	Costs of computer power, fiber cable, other components decreasing; possibly more plant/equipment per constant dollar.
	Technological change	Shift from hardware to software with different cost structure for research, development, deployment; movement toward "intelligent networks," with changing distribution of costs between network and customer premises equipment, also differing depreciation schedules.

expansion, or even whether it has declined as a result of divestiture, several years earlier (although this appears more likely). (See box 9-A.) The possibility of a sustained decline in infrastructure investment, or in long-range R&D, merits very close monitoring, by regulatory agencies and by Congress, for the next several years.

As the debate over the future of communi - cations infrastructure builds to a head in Congress—with strong sentiment both for repealing and for temporarily codifying the MFJ restrictions--RBHCs are walking a very thin tightrope. In making the case to legislators that the present regulatory condi- (ion disfavors their core business to the point

Investment categories	Caveats	Examples/ explanation
	Data quality	Deregulation and Paperwork Reduction Programs reduce regulatory reporting requirements; telecom companies refuse to divulge proprietary data, especially on R&D.
International comparisons	**Industry structure**	**Government ownership vs. private sector; monopoly vs. oligopoly; geographical scale.**
	Accounting practices	**National differences in accounting practices and categories.**
	Regulatory differences	Varying degrees and kinds of data kept; varying public access to data.
	Overly **broad reporting categories**	**Lumping of military, civilian, public and private investment or expenditure. Lumping of network expansion (addition of access lines) and modernization (technological upgrading).**
	Inappropriate comparisons	**AT&T and European equipment manufacturers (i.e. mixed services/technology development vs. pure technology development). RBHCs and European equipment manufacturers (i.e. services providers vs. technology developers).**

SOURCE: OFFICE OF TECHNOLOGY ASSESSMENT, 1993.

that overseas investments represent significantly better options, RBHCs potentially heighten the concern that their captive domestic customers are being neglected. The companies are wary of violating MFJ rules, and the operations for regulated local telephone service are separated from the nonregulated side of the business. There is no evidence of wrongdoing, but RBHCs have failed to assuage fears about cross-subsidization.

The case cannot be made, from the evidence at hand, that R&D expenditures are declining as a direct result of the flow of funds to investment overseas. It is clear, however, that industry R&D expenditures are likely to shrink, or at best to remain flat, in the foreseeable future, and that R&D is

also likely to be more tightly focused on near-term products and services innovation. By industry self-reports, this is an effect of the move toward competition in regulated as well as unregulated markets, and in both domestic and international markets.

Many people in the industry argue that more R&D would be performed or funded by the RBHCs if they were not prohibited from manufacturing telecommunications equipment. It is likely that the allocation of R&D expenditures across sciences (i.e., physical sciences as compared with information sciences) might change, but whether the total volume of R&D expenditures would increase is less certain. It should be noted that even with the prohibition on equipment manufacturing in place, there is a strong technological linkage between manufacturers and users of telecommunications equipment, due to continuing need to modify network equipment, once it is in place, through modular hardware expansion or replacement and generic software revisions.[50] Through Bellcore RBHCs play a central role in the development of technical advisories and requirements, specifications and standards for telecommunications equipment that will be part of or connected to the public-switched networks and that will support the development of services for domestic customers and for export to overseas markets. The ability of U.S. telecommunications firms to compete in overseas markets, for services as well as equipment, will very likely suffer if levels of R&D funding and performance drop significantly.

Close monitoring is needed to detect any trends toward harmful domestic effects from overseas activities, and any harmful effects on overseas competitiveness as a result of unnecessary and unintended domestic policy or regulatory constraints. This monitoring would probably have to be legislatively mandated. Major carriers have said they strongly object to any additional monitoring or mandatory data reporting. However, the FCC already requires common carriers to report expenditures for R&D as well as for infrastructure modernization and expansion in a standard format that could allow comparison of expenditures over time and integration of data across reporting carriers. A new legislative mandate would probably be needed to extend the R&D performance reporting to the regional Bell holding companies and to other telecommunications services providers. Alternately, a new legislative mandate could allow data now collected by the Bureau of the Census and analyzed by the National Science Foundation to be aggregated into smaller, appropriately designed categories to reveal long-range trends in telecommunications-related R&D and make this information available to policy makers in a way that would protect company privacy, Standardized data on all foreign investments would also be needed. However, the Bureau of Economic Analysis already collects some information on direct investment in foreign communicant ions, in highly aggregated form.

New reporting requirements would run directly counter to the strong effort over the last decade to reduce corporate reporting requirements (as described in chapter 8), and would possible strain the current budget of the FCC and the data collection agencies. Since much of this data is already reported in one form or another, however, the additional

50 Harris, op. cit., footnote 14.

reporting burden for industry would be small. Government would incur some additional costs for processing and analysis.

A less direct alternative would be a request from Congress for consultation and cooperation among state regulators, through the National Association of Regulatory Utility Commissioners, with the same end in view. The State regulators, by harmonizing their regulatory practices and reporting requirements, could create a monitoring system and integrate information about infrastructure modernization across state boundaries. They would then be able to develop joint strategies, if needed. for setting infrastructure modernization goals and consumer protection strategies. However, as already noted, state regulators have some conflicting interests with regard to infrastructure modernization, which in part depend on the varying economic development strategies of their states. As a group, nationwide, they may lack both the resources to carry out systematic and coordinated monitoring. and the comprehensive viewpoint to agree on priorities for national and international network development, Moreover, this approach is not as directly applicable to monitoring R&D trends, since this activity is less widely dispersed and the information, considered more proprietary, may be more difficult to extract from telecommunications holding companies. However, unless some action is taken to develop better information, public policy makcrs at both the Federal and state levels will remain in the dark about potentially damaging trends in telecommunications investment.