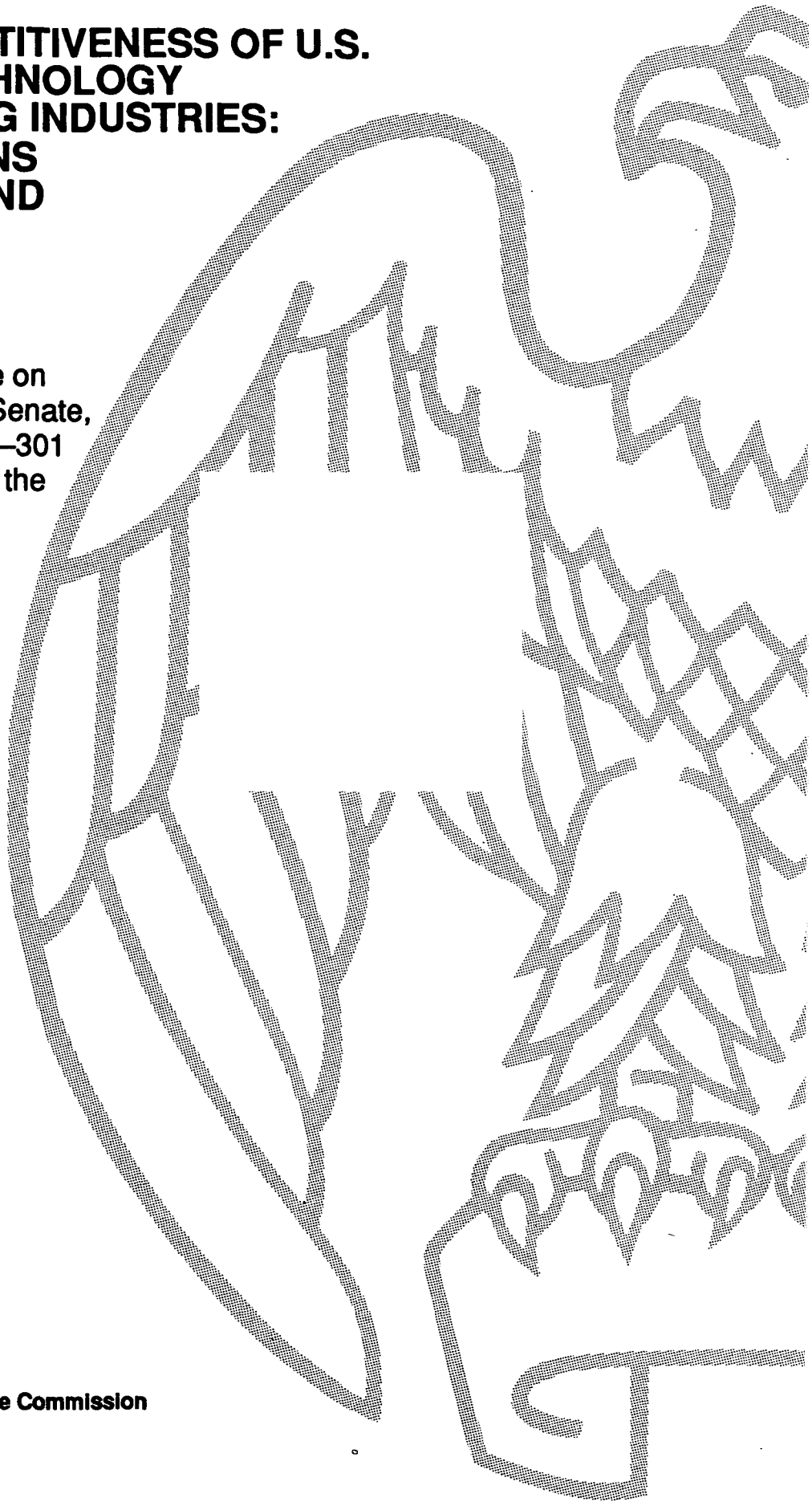
GLOBAL COMPETITIVENESS OF U.S. ADVANCED-TECHNOLOGY MANUFACTURING INDUSTRIES: COMMUNICATIONS TECHNOLOGY AND EQUIPMENT

Report to the Committee on Finance, United States Senate, on Investigation No. 332–301 Under Section 332(g) of the Tariff Act of 1930



USITC PUBLICATION 2439

OCTOBER 1991

United States International Trade Commission
Washington, DC 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

COMMISSIONERS

Anne E. Brunsdale, Acting Chairman

Seeley G. Lodwick

David B. Rohr

Don E. Newquist

Office of Industries
Robert A. Rogowsky, Director

Project Leader
Sylvia McDonough

This report was prepared principally by

Arona Butcher, Scott Baker, Thomas Sherman,
Carey Durkin Treado, Neil Xavier, Christopher Johnson,
Cynthia Payne, and Wanda Tolson
Office of Industries

with assistance from

William Gearhart and Wayne Herrington
Office of the General Counsel

Daniel Shepherdson
Office of Tariff Affairs and Trade Agreements

under the direction of
Norman McLennan, Chief
Services and Electronic Technology Division

Address all communications to
Kenneth R. Mason, Secretary to the Commission
United States International Trade Commission
Washington, DC 20436

PREFACE

This report is one of three on the global competitiveness of U.S. advanced-technology manufacturing industries requested by the Senate Committee on Finance (Finance Committee). In a letter dated September 27, 1990, the Finance Committee directed the Commission, under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)), to conduct investigations on the global competitiveness of the U.S. communications, semiconductor manufacturing and testing equipment, and pharmaceuticals industries, and to furnish reports on the results of the three investigations within one year. Following receipt of the letter, the Commission instituted the three requested investigations, Communications Technology and Equipment (inv. No. 332-301), Pharmaceuticals (inv. No. 332-302), and Semiconductor Manufacturing and Testing Equipment (inv. No. 332-303). Notice of the Commission's institution of the investigation and scheduling of a public hearing for January 17-18, 1991, in connection with the three investigations was posted in the Commission's Office of the Secretary and published in the *Federal Register* of November 15, 1990 (55 F.R. 47812). A copy of the Finance Committee letter is reproduced in appendix A, and a copy of the Commission's notice of investigation and hearing is reproduced in appendix B.

The three investigations represent the second part of a two-step process. Initially, the Finance Committee, in a letter dated June 21, 1990, asked the Commission to identify for the purpose of monitoring, pursuant to sections 332(b), 332(d), and 332(g) of the Tariff Act of 1930, advanced-technology manufacturing industries in the United States, and from the list compiled to recommend three for in-depth study. More specifically, the Committee requested that the Commission (1) within 3 months of receipt of the letter, identify for the purpose of monitoring, using criteria provided by the Committee and any additional criteria of the Commission's choosing, U.S. advanced-technology manufacturing industries, and recommend three of those industries as subjects for comprehensive Commission studies; and (2) within 12 months of the receipt of the Committee's approval (or modification) of the Commission's recommendations, submit its report on three industries the subject of comprehensive studies. In response the Commission, on July 20, 1990, instituted investigation No. 332-294, Identification of U.S. Advanced-Technology Manufacturing Industries for Monitoring and Possible Comprehensive Study. Notice of the Commission's institution of investigation No. 332-294 was posted in its Office of the Secretary and published in the *Federal Register* (55 F.R. 30530) of July 26, 1990. Although a public hearing was not held, all persons were afforded the opportunity to submit written views concerning the industries to be included on the list and that may be the subject of a comprehensive study. A copy of the Finance Committee's letter of June 22 is also set forth in appendix A.

The Commission's report on investigation No. 332-294 (USITC Publication 2319, September 1990) was transmitted to the Committee on September 21, 1990. In its report, the Commission identified ten advanced-technology industries and recommended the following three for comprehensive study: communications technology and equipment; pharmaceuticals; and semiconductor manufacturing and testing equipment. In its letter of September 27, 1990, the Committee acknowledged receipt of the Commission's report and approved the Commission's recommendation concerning the three industries for comprehensive study.

In its June 21 letter, the Committee requested that the Commission, in identifying the industries to be monitored, consider the following criteria as well as any other criteria it might choose—

(1) Industries producing a product that involves use or development of new or advanced technology, involves high value-added, involves research and development expenditures that, as a percentage of sales, are substantially above the national average, and is expected to experience above-average growth of demand in both domestic and international markets; and

(2) benefits in foreign markets from coordinated—though not necessarily sector specific—policies that include, but are not limited to, protection of the home market, tax policies, export promotion policies, antitrust exemptions, regulatory policies, patent and other intellectual property policies, assistance in developing technology and bringing it to market, technical or extension services, performance requirements that mandate either certain levels of

investment or exports or transfers of technology in order to gain access to that country's market, and other forms of government assistance.

The Committee requested that the report of the three industries to be selected include at least the following information—

> Existing or proposed foreign government policies that assist or encourage these industries to remain or to become globally competitive, existing or proposed U.S. Government policies that assist or encourage these industries to remain or become globally competitive, and impediments in the U.S. economy that inhibit increased competitiveness of these U.S. industries.

A consolidated public hearing in connection with investigation Nos. 332-301-303 was held in the Commission Hearing Room on January 17, 1991. Persons appearing at the hearing were required to file requests to appear and prehearing briefs by January 3, 1991, and to file any posthearing briefs by January 31, 1991. In lieu of or in addition to appearances at the public hearing, interested persons were invited to submit written statements concerning the investigations. The North American Telecommunications Association (NATA) of Washington, D.C. was the only interested party that presented testimony at the public hearing in connection with inv. No. 332-301 (see app. C).

The information and analysis provided in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under statutory authority covering the same or similar subject matter.

CONTENTS

CONTENTS—*Continued*

CONTENTS—*Continued*

CONTENTS—*Continued*

EXECUTIVE SUMMARY

Background

The global competitiveness of the U.S. economy became a growing concern during the 1980s due to the sustained deterioration of the U.S. trade balance. The loss of market share in high technology products, previously considered invulnerable to foreign competition, exacerbated this concern. In response to this concern, the USITC has undertaken a series of studies which attempts to provide a thorough and methodical analysis of the global competitiveness of high technology industries.

This study assesses competitiveness in the communications equipment industry, an industry incorporating some of the most advanced technology available and contributing to the technological advance of other industries. The communications industry encompasses network and terminal equipment generally associated with private and common carrier networks. The time period covered by this study begins with the establishment of telephone communications at the turn of the century and continues to the present. The countries analyzed in this study have been divided into two groups: major equipment-producing countries, concentrated in Europe, North America, and Asia; and nonmajor equipment-producing countries, which represent emerging markets.

This study first defines measures of competitiveness, then identifies, compares, and analyzes the principal determinants of competitiveness. These determinants were selected to reflect industry-specific trends rather than general, economy-wide factors. The information for this study was collected through foreign and domestic contacts with manufacturers, consumers, regulators, and researchers, and by a review of studies by governments, associations, consultants, and academicians relating to this industry.

Competitiveness can be defined at several levels, including individual firm, industry, and nation. This study will assess industry competitiveness in international markets, which is measured by U.S. export performance relative to that of the other major equipment producers in developed and emerging markets.

Findings

The communications equipment industry is undergoing rapid transformation due to changes occurring throughout the world in regulation, technology, and markets. The industry, traditionally characterized by strict government regulation, slow technological change, and a limited number of purchasers, is becoming much more dynamic. The ability to adapt to a changing environment and to influence the direction of future changes will determine which firms are competitive in the industry.

U.S. research and development (R&D) policy favors defense and basic research over commercial or industrial research. In contrast, foreign governments fund more industrial R&D than does the U.S. government and some think this has helped foreign firms commercialize technology more rapidly than their U.S. counterparts. In an industry with high R&D costs, such as communications, government support and risk sharing can convey a competitive advantage.

AT&T traditionally maintained a tremendous competitive edge in technology due to its access to the results of R&D from Bell Laboratories. However, with divestiture of the Bell operating companies (BOCs), AT&T lost a major source of R&D funding. Because the divestiture placed restrictions on BOC research and development activities, it is felt that European and Japanese firms benefit more than North American firms from research conducted by the principal telecommunications authorities.

Preferential procurement policies and divergent national equipment and service standards have worked to lessen competition in communications equipment markets. In addition, entrenched suppliers benefit from the network's installed equipment base because most service providers are reluctant to incorporate possibly incompatible or untried equipment in their systems. These factors tended to limit the number of communications equipment producers and constrained them to serving their domestic markets.

With the advent of liberalization, however, access to both equipment and service markets is increasing. This change, reportedly, will increase the autonomy of communications equipment purchasers and create a more competitive environment. In some countries, such as the United States and the United Kingdom, the openness of the market to nontraditional equipment suppliers appears to have increased. Liberalization is a relatively recent phenomenon and the extent and pace of the changes have not been equal in all countries. Until liberalization becomes more uniform throughout the world, equipment producers in protected home markets will have a competitive advantage over those in more open markets.

A number of industry experts believe that the principal European and Japanese producers continue to have an advantage over AT&T in selling in overseas markets due to greater marketing expertise developed over the years. Most foreign producers' home markets are too small to support the level of R&D necessary in the communications equipment industry, forcing these producers to develop other markets. In contrast, AT&T was pressured to give up its international operations early in its history, and has just recently returned to major foreign markets.

In order to recover mounting R&D costs, most firms are finding it necessary to seek export markets. It appears that major European and Japanese exporters benefit to a greater extent than U.S. producers from government financing, loan guarantees, and aid for sales to developing countries. U.S. firms also reportedly encounter a set of restrictive export controls that are much stricter than those of their competitors.

Technological change, liberalization, and market globalization share a common thread. Each is in a period of transition, during which industry norms are shifting ground. At the same time, the pace of change in each area is increasing. Therefore, competitiveness in the communications equipment industry ultimately depends on how firms and nations adjust to change. Those industry players that recognize the transformation of the industry and prepare for it will succeed; those that do not will be left behind.

CHAPTER 1
INTRODUCTION

Purpose of Study

The global competitiveness of the U.S. economy became a growing concern during the 1980s due to the sustained deterioration of the U.S trade balance. The loss of market share in high-technology products, such as microelectronics, previously considered invulnerable to foreign competition, exacerbated this concern. When macroeconomic adjustments, such as a significant devaluation of the dollar, failed to immediately improve the trade balance, the debate on competitiveness became an increasing focus of policymakers.

The information necessary to assess industry-level competitiveness is often scattered, insufficient, or imprecise. This study is part of a series requested by the Senate Committee on Finance that attempts to provide policymakers and other interested groups with a thorough and methodical analysis of the determinants and status of global competitiveness in high-technology industries.[1] The study focuses on the communications equipment industry, an industry that both incorporates some of the most advanced technology available and contributes to the technological advance of other industries.[2] Key areas such as government policy, industry evolution, and technological change are examined to provide an overall assessment of the competitiveness of the industry.

Approach

The economic analysis developed to assess the competitiveness of the communications equipment industry first defines measures of competitiveness; it then attempts to identify, compare, and analyze the principal determinants of competitiveness in the communications equipment industry. The determinants were selected to reflect industry-specific trends, rather than more general, economywide factors. They are divided into influences that are internal to the firm, such as research and development, and those that are beyond the firm's control, such as government policies. Regression analysis is used to determine the impact of the external and internal factors on the competitiveness of the industry. The study also provides a comparative description of government policies that could enhance or impede the competitiveness of a nation's communications equipment suppliers and traces the evolution and current status of the global industry. Unless otherwise noted, country-based information includes both domestic and foreign-owned operations; however, references to a particular firm will include foreign operations, if any.

Information for this analysis was collected from a variety of sources. Contacts with domestic and foreign manufacturers, consumers, regulators, and researchers provided a major portion of this information. The work of research organizations within universities, government agencies, and national and international standard-setting bodies was also collected and analyzed. In-person or telephone interviews were conducted in the United States, Europe, and the Far East with principal equipment manufacturers and communications service providers.

A public hearing was held on January 17, 1991, and testimony on the issue of competitiveness was given by the North American Telecommunications Association (NATA). In its statement, NATA urged government policymakers to focus on initiatives that stimulate competition, by promoting infrastructure improvements, research and development, and education. In a post hearing brief, Bell Atlantic stated that the elimination of the manufacturing restrictions imposed on the Bell operating companies (BOCs) would enhance U.S. competitiveness by increasing research and development, innovation, and exports.

Scope of Study

The Industry Defined

Within this study, the communications equipment industry encompasses network and terminal equipment that is generally associated with private and common carrier[3] networks (figure 1-1). These product categories are based on equipment function, rather than location.[4] Television and radio broadcast equipment is not within the bounds of this study. Similarly, although computers are increasingly incorporated into communications networks as processors of information, they are considered a separate industry. However, modems, which connect computers to the network, and component software, to the extent that it is integral to the operation of the system, are included in this study.

Network equipment can be divided into two categories, transmission and switching. Transmission equipment includes copper wire, coaxial and fiber-optic cable, microwave radio equipment, and satellites. The principal function of transmission equipment is to transport the signal. Switching equipment routes a signal, such as the telephone number dialed from the sender, through the

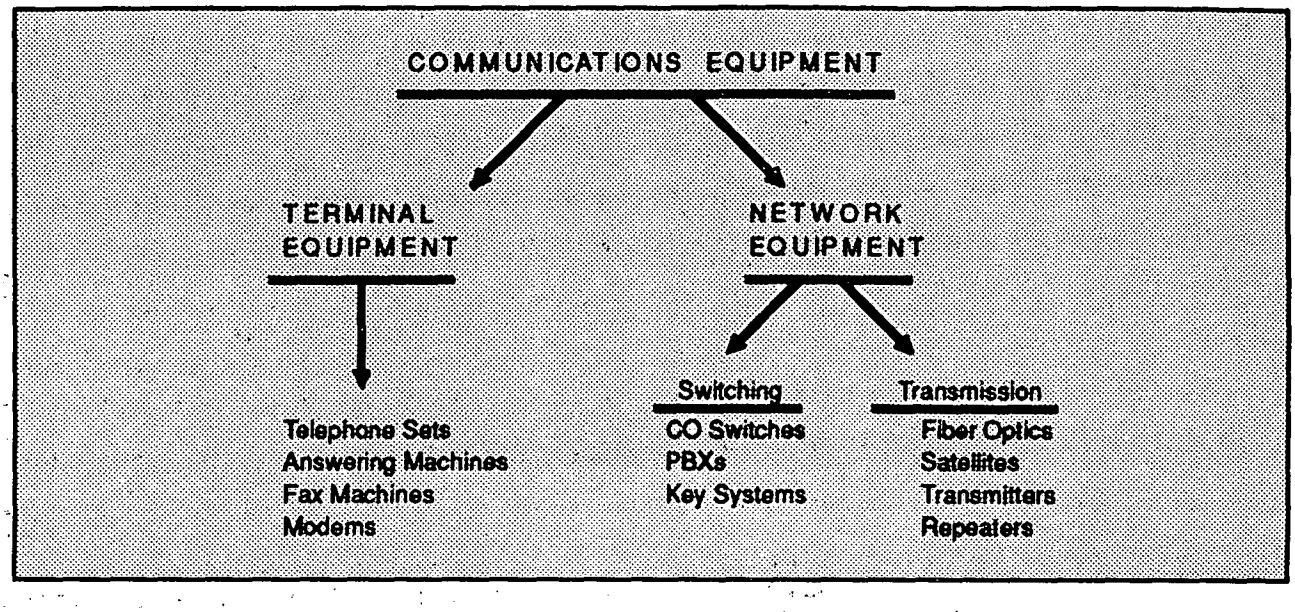
[1] The series is described in United States International Trade Commission (USITC), *Identification of U.S. Advanced-Technology Manufacturing Industries for Monitoring and Possible Comprehensive Study (investigation No. 332-294)*, USITC publication 2319, September 1990, pp. 15-16.

[2] The reasons for selecting the communications equipment industry are also described in USITC, *Identification of U.S. Advanced-Technology Manufacturing Industries*.

[3] A common carrier is a company that provides communications services to the general public.

[4] Communications equipment can also be categorized according to location. For example, customer premises equipment (CPE) is any equipment purchased by and for use on the premises of the user.

Figure 1-1
Communications equipment product coverage



Source: Staff of the U.S. International Trade Commission.

transmission system, to the receiver. Recent developments in digital technology and software allow switches to perform additional services, such as call forwarding or caller identification, and to send information associated with each transmission to a database for storage and retrieval. This study includes switching equipment of all sizes, from the largest central office (CO) switch to the smallest private branch exchange (PBX).[5]

Terminal equipment encompasses a broad range of items, all of which can be attached to the communications network. This equipment initiates and receives signals transported over the network. Some of the most common types of terminal equipment are telephone sets, including cellular and cordless; telephone answering machines; facsimile machines; and modems.

The period covered by the study begins with the establishment of telephone communications around the turn of the century and continues to the present. This historical approach permits evaluation of forces that have shaped the industry and influenced its competitiveness. However, the focus of this analysis will be on events that occurred in the last two decades. The study includes industry-specific data, which form the basis for economic analysis of the industry.

The countries analyzed, both qualitatively and quantitatively, are divided into two groups. The first group, major equipment-producing (MEP) countries, includes the largest producers in the communications equipment industry which also represent significant markets for such equipment. They are concentrated in North America, Europe, and Asia, and include Canada, France, Germany, Japan, Sweden, the United Kingdom, and the United States. The MEP countries are the world's largest markets but are characterized by relatively few competitors in many market segments. The second group contains nonmajor equipment-producing (NEP) countries which represent emerging markets where MEP countries compete with each other for market share. The NEP countries include Australia, Brazil, Greece, Indonesia, Jordan, Malaysia, Mexico, New Zealand, the Philippines, Poland, Saudi Arabia, South Korea, Spain, Thailand, Turkey, and Venezuela. Although some of these countries produce communications equipment, they neither produce a complete line of equipment for domestic consumption nor export equipment other than products at the lower end of the technology scale, such as telephone sets. As a result, they are analyzed mainly as markets, rather than producers.

Competitiveness Defined

Competitiveness can be defined at the level of the nation, the industry, and the firm. A consensus in the literature suggests that national competitiveness represents a dynamic concept that goes beyond issues of profit, loss, and the trade balance to include the general standard of living.[6] The definition of national competitiveness from the President's Commission on Industrial Competitiveness follows:

[5] The PBX is also known as a private automatic branch exchange (PABX).

[6] See ch. 3 and app. F for a review of the literature on competitiveness.

> Competitiveness is the degree to which a nation can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining or expanding the real incomes of its citizens.[7]

Industry and firm-level competitiveness, on the other hand, are often defined as the ability to sustain market position profitably in a competitive environment as products and production processes evolve. This definition considers relative long-run profit performance and highlights the fact that competitiveness requires dynamic responses to changing technologies and evolving market conditions.

This study assesses the competitiveness of the communications equipment industry at the industry level. However, it is important to remember that competitiveness in the communications equipment industry has implications for national competitiveness. Due to the rapid pace of technical change in high-technology industries, these industries tend to be characterized by higher productivity, which in turn contributes to higher national standards of living. This study includes economic analysis in which international competitiveness of the communications equipment industry is measured by the export performance of the United States relative to the other MEP countries in MEP and NEP markets.

Organization of Study

This chapter has provided a general background on the approach and scope of this study assessing the global competitiveness of the communications equipment industry. Chapter 2 profiles the evolution of communications equipment industries in the MEP countries in terms of the sources and status of competitiveness. Chapter 2 also describes the current structure of the global communications equipment industry and linkages to other sectors of the economy. A review of literature concerning the competitiveness of this industry and a summary of industry opinion regarding this issue are given in chapter 3.

Chapter 4 outlines and compares the external determinants of competitiveness embodied in a variety of national government policies, such as antitrust, regulation, research and development, trade, and intellectual-property rights.

Chapter 5 presents a comparative analysis of factors affecting the relative competitiveness of communications equipment industries in the MEP countries. This chapter addresses the internal determinants of competitiveness and expands on the impact government policies have had on the industry.

Chapter 6 draws together the information from the previous chapters to form a quantitative analysis of industry competitiveness using relative export performance as the measure of competitiveness. Chapter 6 analyzes the relative impact of the factors identified in chapters 4 and 5 on U.S. export performance in both MEP and NEP markets.[8] Chapter 7 summarizes the findings of the study.

[7] The Report of the President's Commission on Industrial Competitiveness, *Global Competition: The New Reality*, 1985, vol 1., p. 6.

[8] Data for the analysis in ch. 6 are drawn from international organizations, such as the Organization for Economic Cooperation and Development (OECD) and the United Nations, which offer comparable international data.

CHAPTER 2
THE GLOBAL COMMUNICATIONS EQUIPMENT INDUSTRY

Introduction

Over the past century, technological, regulatory, and economic factors have determined both the structure and the nature of competition in the global communications equipment industry. This chapter first briefly reviews the important events prior to World War II that helped form the structure of the market and industry in the United States and important foreign markets.

Next, technological developments and consequent changes in regulatory thinking in the United States after the war are reviewed. These changes transformed the industry from a monopoly to a competitive market place and eventually led to similar changes in other countries. It then describes the current structure of the global communications equipment industry and its present state of technology. Finally, it discusses important linkages of the industry to other sectors of the economy.

Evolution of the Industry

Industry Beginnings

The invention and patenting of the telephone by Alexander Graham Bell in 1876 (figure 2-1) marked the birth not only of a new technology but of a new industry.[1] After securing patent rights, associates of Bell established the American Bell Telephone Co. to exploit the telephone patents, with little competition in the early days of the industry.[2]

In 1881, American Bell purchased a major interest in Western Electric, the manufacturing subsidiary of Western Union and the world's largest electrical equipment producer at that time.[3] As a result of its technology and patents, American Bell became a near-monopoly supplier of both telephone services and equipment. The company retained its dominant position until 1893, when its major patents expired and a large number of new competitors entered the market in both the services and manufacturing sectors. However, soon afterwards American Bell regained a technological edge when it purchased the patent rights to the loading coil, an advance that permitted transmission of analog electrical signals over much greater distances than previously possible.[4]

American Bell, renamed American Telephone and Telegraph (AT&T) in 1907, used its new long distance service as a competitive weapon, refusing to connect independent local exchange territories to the new long distance network. This refusal led to serious financial difficulties for many independent companies, making them easy takeover targets for AT&T.[5] By 1911, AT&T had acquired so many local telephone companies that they presented a management problem. The company announced a consolidation, resulting in a smaller number of State and regional companies, laying out the geographical lines of the Bell operating companies (BOCs) that remain today. In that same year, AT&T purchased enough stock in the faltering Western Union Telegraph Co. to gain control and move toward regaining its monopoly.

Moves Toward Regulation

Prior to 1912, AT&T remained adamantly against interconnection of its facilities with independent systems. However, public pressure for interconnection mounted, as many subscribers to independent telephones, living in areas not served by the Bell system, wanted access to long distance service. In that year, a group of independent companies protested to the Department of Justice that AT&T was operating in violation of the antitrust laws. Shortly afterwards, the Interstate Commerce Commission (ICC), which had assumed jurisdiction over the telephone industry in 1910, began an investigation to determine if AT&T was attempting to monopolize communications in the United States.

In the 1913 compromise between AT&T and the Government, known as the "Kingsbury Commitment," AT&T agreed to (1) dispose of its holding of Western Union stock so as to reduce its control and management of that company; (2) discontinue further acquisition of independent telephone companies except with the approval of the ICC; and (3) make arrangements to allow independent companies to connect to AT&T's long distance network. The Kingsbury agreement dampened AT&T's efforts to create a national monopoly in all areas of communication and imposed greater regulation by the Federal Government, under jurisdiction of the ICC. However, in return for accepting some government regulation, AT&T maintained virtual control over the telephone market by owning the technology required for competitive success and working in partnership with government in providing "end-to-end" universal service in the United States.[6]

Between 1907 and 1922, all but a handful of States adopted some form of public utility commission to

[1] Robert W. Crandall, *After the Breakup: U.S. Telecommunications in a More Competitive Era* (Washington, DC: The Brookings Institution, 1991).

[2] Gerald R. Faulhaber, *Telecommunications in Turmoil: Technology and Public Policy* (Cambridge, MA: Ballinger Publishing Co., 1987), p. 1.

[3] John Brooks, *Telephone: The First Hundred Years*, (New York: Harper and Row, 1975), p. 129.

[4] Ibid.

[5] Ibid, p. 133.

[6] Faulhaber, pp. 6 and 7.

Figure 2-1
Significant events in the history of the global communications industry

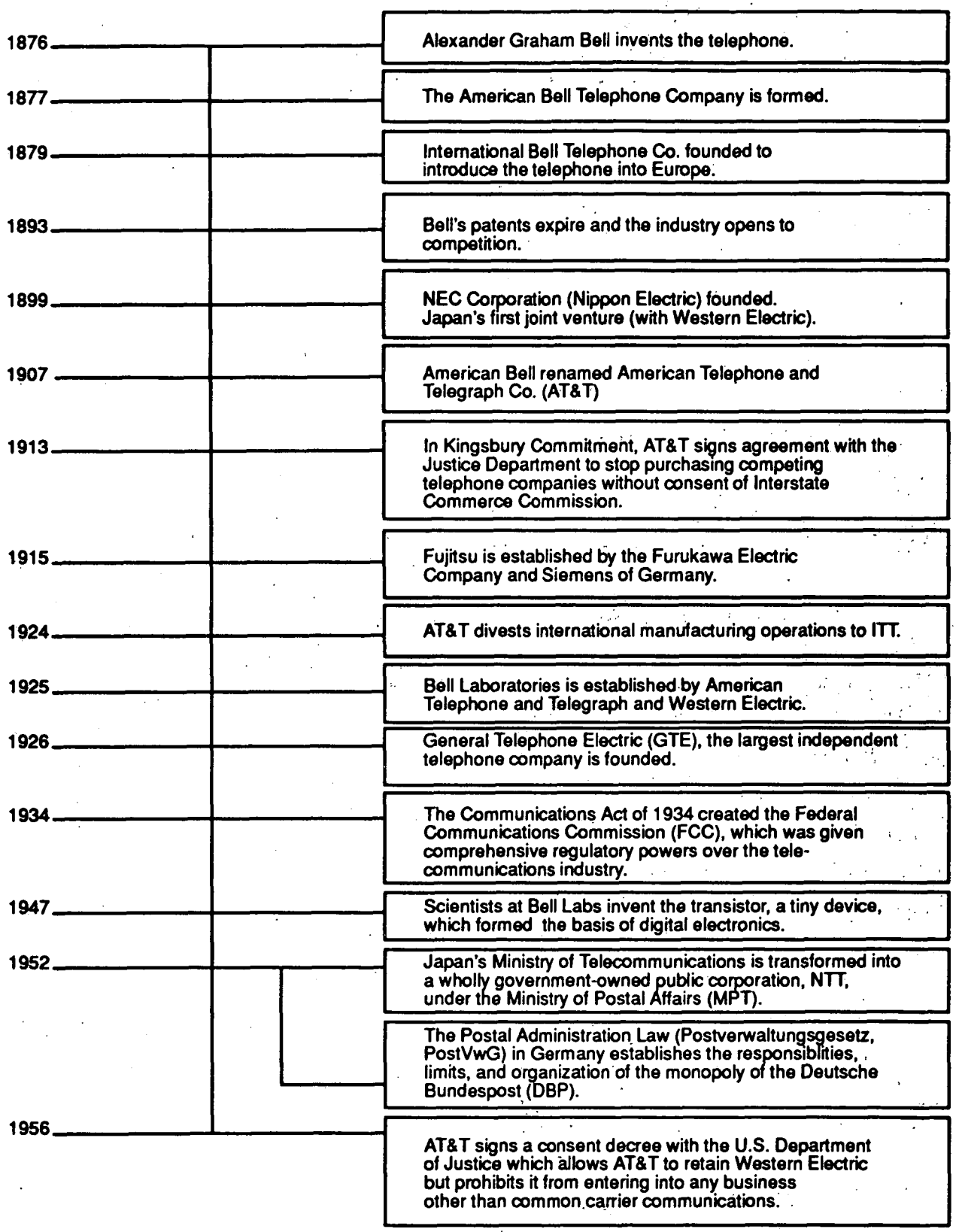
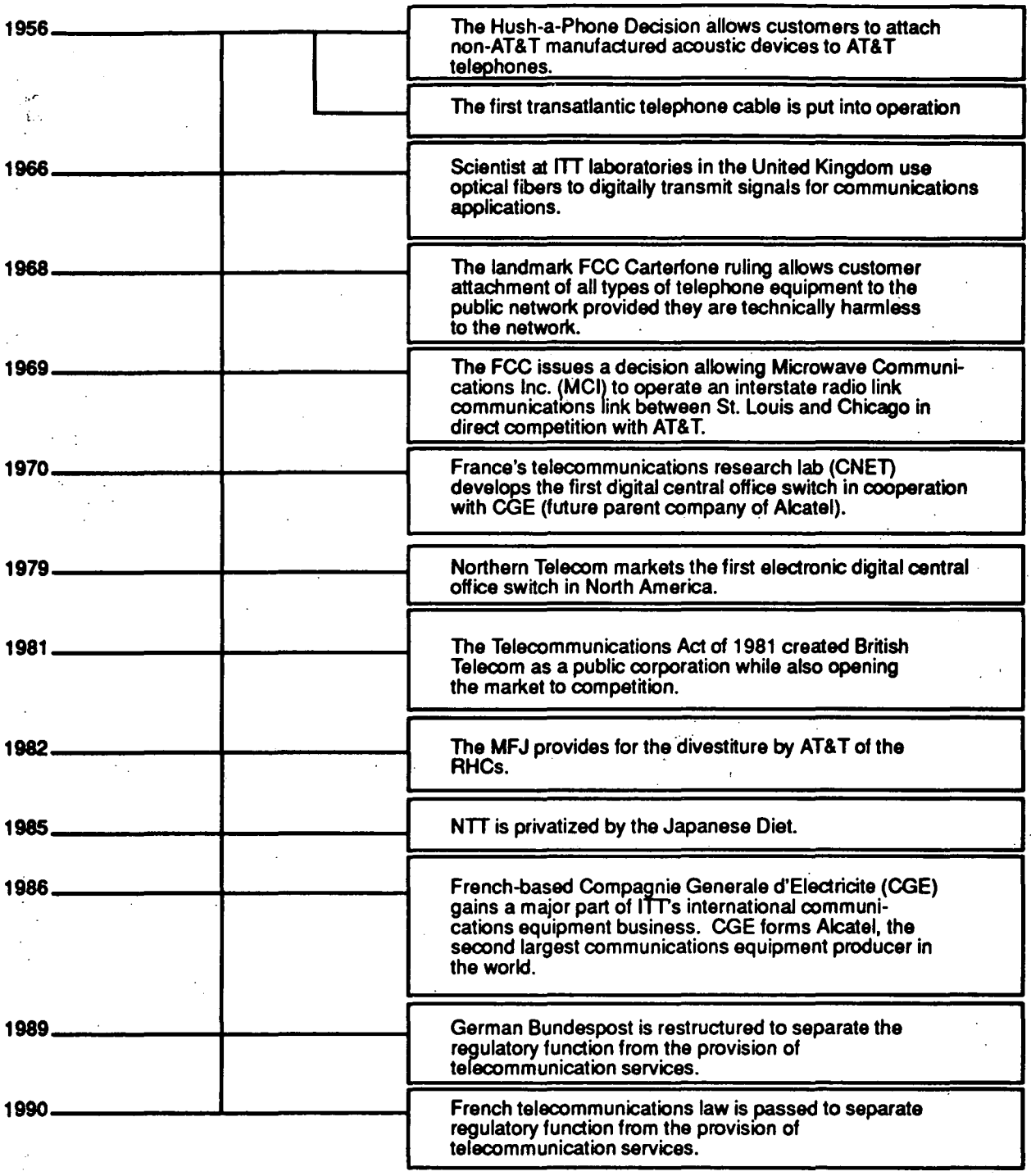


Figure 2-1—Continued
Significant events in the history of the global communications industry



Source: Compiled by staff of the U.S. International Trade Commission.

regulate intra-State telephone service.[7] After a number of years of perfunctory jurisdiction under the ICC, federal regulation of all interstate electrical communication, including telephone, telegraph, and radio, was vested in the Federal Communications Commission (FCC) by the Communications Act of 1934. State regulatory authorities maintained jurisdiction over local and intrastate telephone activities and rates of return.

International Developments

Europe

In 1879, Bell's associates founded the International Bell Telephone Co. to introduce the telephone in Europe. Both Bell and Western Union obtained franchises for operating telephone systems in major European markets, such as the United Kingdom, France, and Germany. However, the powerful government postal, telephone and telegraph (PTT) monopolies in those countries established competing telephone networks and obtained control of the private networks before the century ended, absorbing them into national postal and telegraph monopolies. Nevertheless, as a result of its patents and technology, Bell was able to remain an equipment supplier in Europe, establishing first the Bell Telephone Manufacturing Co. of Antwerp, Belgium and then absorbing that company into a new holding company, the International Western Electric Corp.

International Western Electric was to remain the dominant supplier of telephone equipment to European government PTTs through the early decades of the new industry. However, by 1924, the firm faced increased competition from national suppliers such as Siemens (Germany), Philips (the Netherlands), L.M. Ericsson (Sweden), and the General Electric Corp. (Great Britain),[8] which were nurtured by their respective governments as "national champions" through government procurement activities.

Although AT&T's technological leadership enabled it to remain a significant supplier of equipment in important foreign markets, such as Europe, during the early decades of the industry, concerns existed in the United States that U.S. telephone customers were subsidizing the growth of AT&T's foreign installations. As a result, on September 30, 1924, the U.S. Department of Justice pressured AT&T to divest itself of its substantial European operations to a then fledgling U.S.-based holding company, International Telephone and Telegraph Co. (ITT).[9] AT&T's departure from Europe signaled an end to significant international exposure for the company, lasting for the next 60 years.

Although European PTTs continued to favor national suppliers, most preferred to have at least one alternative source of supply to provide competition. ITT was able to successfully fulfill the role of alternative supplier in major countries like Great Britain, Germany, and France and competed with other internationally oriented competitors such as the Swedish-based L.M. Ericsson and the Dutch-based Philips in smaller European markets with little manufacturing capacity of their own.

Japan

As in Europe, the Bell System was instrumental in establishing the telephone industry in Japan. Japan's premier electronics and telecommunications giant, the Nippon Electric Corp. (NEC), was formed as Japan's first joint venture in partnership with AT&T's Western Electric Co. in 1899.[10] The three other major suppliers of communications equipment in Japan were established during the first two decades of the 20th century. OKI Electric was established in 1912 in a technology-transfer arrangement with Great Britain's General Electric Corporation (GEC). Fujitsu was established in 1915, as the result of an alliance between Furukawa Electric Company and Siemens of Germany. Hitachi, Ltd., founded in 1910, was the only major Japanese communications equipment supplier established independent of foreign connections.

The Japanese Ministry of Communications, established in the late 1800s to control mail, the telegraph, maritime shipping, and lighthouses, added telephones and electric power generation to its jurisdiction in 1891. From 1885 to 1985, the Government supplied and monopolized all Japanese telecommunications. Over the years, the Ministry of Communications established close research, development, and procurement relationships with NEC, Fujitsu, Hitachi, and OKI. After the Second World War when operation of Japanese communications were entrusted to a wholly government-owned public corporation, Nippon Telephone and Telegraph (NTT), these companies became known as the "NTT family."

North America

Canada's telephone service and equipment industries were established at the end of the last century and developed in a similar manner as those in the United States. The two major U.S. telephone companies, AT&T and General Telephone and Electric (GTE), were instrumental in establishing the Canadian industry. Bell Canada and its captive equipment supplier, Northern Wire and Cable, were founded by AT&T and Western Electric and remained a part of the

[7] Douglas D. Anderson, "State Regulation of Electric Utilities," *In The Politics of Regulation*, edited by James Q. Wilson (New York: Basic Books, 1980).

[8] General Electric Corp. is not related to U.S.-based General Electric Co.

[9] Robert Sobel, *ITT: The Management of Opportunity* (New York: The New York Times Book Co., 1982), pp. 41 and 42.

[10] Chalmers Johnson, *MITI, MPT, and the Telecom Wars: How Japan Makes Policy for High Technology*, Berkeley Roundtable on the International Economy (Berkeley, CA: University of California, September 1986).

U.S.-based Bell System until 1956. At that time, Bell Canada became independent of AT&T and retained its equipment manufacturer, renamed Northern Telecom.

Similarly, GTE, which was founded in 1926, established Canada's second-largest telephone company, British Columbia Telephone and also founded and maintained a controlling interest in Microtel, a captive equipment supplier. Bell Canada and British Columbia Telephone, the two largest providers of telephone services in Canada, were eventually made subject to Federal regulation under the Canadian Radio-Television and Telecommunications Commission (CRTC).

Structure of the Global Industry

The structure of the global communications industry was well established after the first several decades of the 20th Century. The provision of telephone service was, with few exceptions, a virtual monopoly in all major countries of the world. In the United States, AT&T had succumbed to Federal and State regulation of local and long distance service operations in return for an almost total monopoly on provision of universal service. In addition, although AT&T was pressured to give up its international equipment-manufacturing entity, it retained the Western Electric equipment-manufacturing unit as a captive supplier to its Bell operating units in the United States.

Some independent telephone companies remained in the U.S. market, including GTE, which had its own captive manufacturing unit. However, in general these independent companies served rural areas offering little competition to AT&T. The Canadian market and industry structure was very similar to that in the United States, consisting largely of privately owned, government-regulated telephone service providers affiliated with captive equipment suppliers.

In much of the rest of the world, including almost all of Europe and Japan, nationally owned telecommunications authorities both regulated and operated telecommunications networks. Unlike in the United States and Canada, rather than developing a captive source of equipment supply, these authorities typically procured equipment from privately owned telephone and electrical equipment producers, generally giving strong preference to a small group of nationally based firms. However, some internationally oriented firms, like ITT, Ericsson, and Philips, were able to obtain portions of this market by establishing or acquiring local manufacturing and research facilities and providing an alternative to dominant national firms in a number of European countries.

Technological Developments

After developing reliable basic telephone and transmission equipment, the primary technical problem for AT&T was to develop efficient switching systems to connect circuits and subscribers. To more effectively coordinate its development efforts in switching and transmission technologies, in 1925 AT&T's research and engineering capabilities were formally consolidated into Bell Telephone Laboratories—equally owned by AT&T and Western Electric.[11] Because the basic components—telephones and transmission and switching devices—provided an acceptable level and quality of service, Bell Laboratories focused on innovations to reduce the costs of existing products and services rather than on innovations of new products and services.[12]

A major problem for AT&T and Bell Labs, however, was that capital facilities in communications had very long physical lives and rapid, uncontrolled technological innovation could make equipment obsolete before its costs had been fully recovered.[13] Consequently, control over the process and timing of innovation was important to reduce the risk of unanticipated technological advance and protect the profitability of sunk assets.

Because technological and regulatory developments provided AT&T with almost total control over the communications market, the company was able to concentrate its development efforts on its own specific needs rather than on innovation.[14] Instead of introducing new products, AT&T concentrated on making old products work better. Under these conditions, AT&T had little need to develop marketing skills, the lack of which would prove disadvantageous when competitive conditions were introduced into the market.[15]

AT&T's technological strategy coincided with the preference of regulators for communications networks and equipment with long depreciation lives, which postponed the recovery of costs to future customers, making it politically attractive. Consequently, the interplay of technology, economics, and regulatory politics worked to create the necessary conditions for AT&T's continued monopoly (figure 2-2).

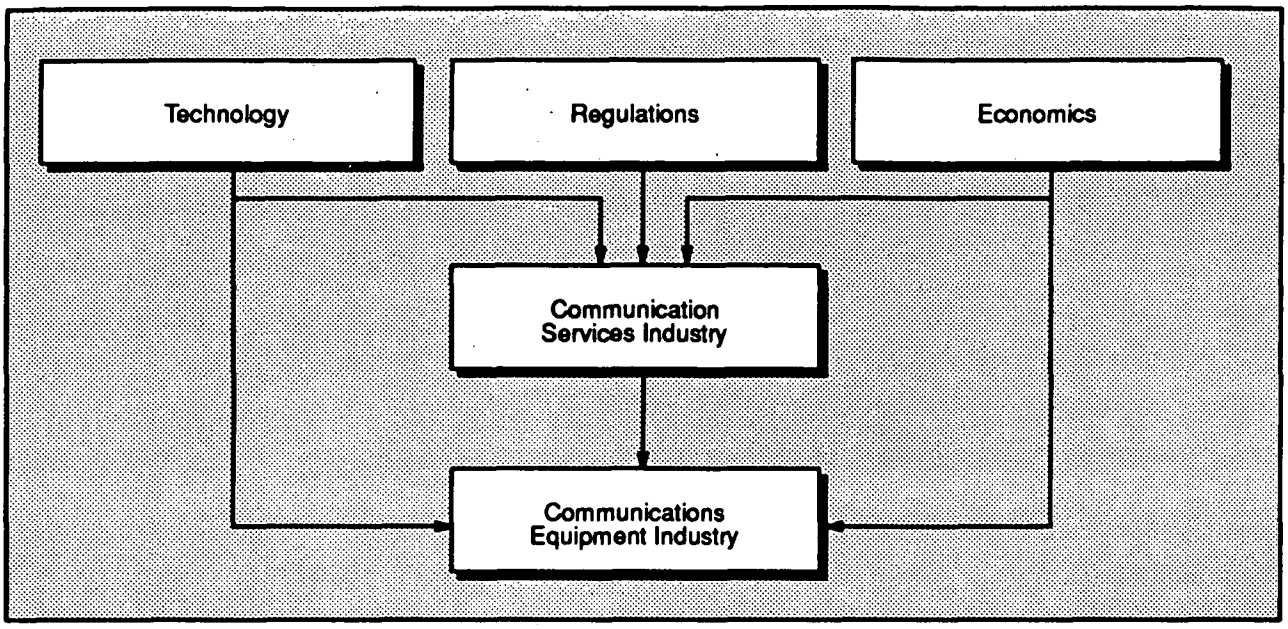
Post-war Developments

Even though AT&T's introduction of new products and services remained slow, basic research by Bell Labs flourished in the period during and immediately after World War II. Bell Labs "practically founded the field of solid-state physics" during this time.[16] This work resulted in the invention of the transistor, which formed the basis of digital electronics and the subsequent computer revolution that would later profoundly affect the communications industry.

With the development of microelectronics, electromechanical switching systems were replaced by computer systems, known as stored program control,

[11] Brooks, pp. 12 and 13.
[12] Faulhaber, p. 9.
[13] Ibid.
[14] Ibid.
[15] Ibid., p. 10.
[16] Ibid., p. 33.

Figure 2-2
Factors affecting the structure of the communications equipment industry



Source: Staff of the U.S. International Trade Commission.

time division switches.[17] Such switches had a broad range of advantages, from easy maintenance and reconfigurability to the addition and execution of a large number of intelligent functions previously not possible, such as the re-routing of calls.[18] However, by the postwar period, the Bell Lab technology was diffusing to other engineers and firms.

> The very nature of scientific research . . . contributed to this diffusion. While specific devices can be patented, the theories upon which the devices are based cannot be. . . . For example, the transistor could be (and was) patented; but the theory of solid state physics could not be patented, nor kept secret. Others could use the theory to make their own competitive advances to challenge Bell.[19]

Developments in transmission technology during and after World War II also had a dramatic influence on the structure of the communications services and equipment industries. Advances in radio communications, especially microwave systems, were used extensively during the war and were found to be particularly effective in transmitting data in point-to-point communications. Unlike traditional telephony, which depended on the establishment of extensive rights-of-way for stringing or laying copper and coaxial cables, requiring huge fixed costs, the microwave radio systems merely required the placement of radio antennas and transmitters at selected points along the network for transmission.

Because the economies of scale in microwave transmission were small compared with those of traditional telephony, after the war, a number of new competitors to AT&T entered the market. Pent-up demand by business provided impetus for the establishment of corporate communications networks able to take advantage of the point-to-point capabilities of microwave. By the late 1950s, the cost of reliable microwave systems had been reduced to the extent that large geographically dispersed firms were considering purchasing and operating their own private microwave systems to carry their internal telephone traffic.[20] These firms had previously linked their plants and offices together with Bell System communications lines. The smaller economies of scale also challenged the natural monopoly argument that had thus far protected the monopoly status of communications suppliers like AT&T.

Market Liberalization

During World War II, AT&T focused much of its efforts toward defense requirements rather than consumer needs. However, after the war, pent-up

[17] R.F. Rey, *Engineering and Operations in the Bell System*, 2 ed. (Murray Hill, N.J.: AT&T Bell Laboratories, 1983).

[18] Herbert Ungerer, *Telecommunications in Europe: Free Choice for the User in Europe's 1992 Market* (Luxembourg: Office for Official Publications of the European Communities, 1988), p. 39.

[19] Faulhaber, pp. 33 and 34.

[20] Ibid., p. 24.

demand by residential and business consumers exceeded AT&T's capacity and a number of new competitors to AT&T attempted to enter the market. At first, AT&T successfully fought the entry of potential competitors into its monopoly markets. However, the Justice Department became increasingly concerned that AT&T's vertical integration in producing equipment and providing telephone services was violating antitrust laws. Therefore, the Department filed an antitrust suit against AT&T, calling for a competitive procurement process and the divestiture of AT&T's equipment manufacturing arm, Western Electric. In 1956, the case was settled with a consent decree that allowed AT&T to retain Western Electric but required the company to license its patents to other firms. This could only lead to further diffusion of AT&T's technology. The decree also limited AT&T to manufacturing communications equipment and prohibited it from engaging in any businesses other than provision of regulated common carrier communications services.[21]

In another case in 1956, the District Court of Appeals Hush-a-Phone Decision set a precedent foreshadowing even greater future competition in the industry. The decision allowed customers, for the first time, to attach non-AT&T manufactured or licensed acoustic devices to AT&T telephones, provided they caused no risk of harm to the telephone network. The trend towards increased competition was further bolstered by the FCC's 1968 Carterfone Decision, which permitted connection of an acoustic coupler device for two-way radios to the public network. These decisions greatly increased opportunities for independent manufacturers and distributors of communications equipment and provided business and residential consumers with a greater variety of products.

During this period of increased competition and deregulation, parallel developments occurred in the services segment of the communications market. Prior to 1959, only regulated telephone or telegraph companies, such as AT&T, were permitted to offer standard telecommunications services in the United States; no person or company could build a personal network. In 1956, the FCC began to investigate the possibility of allocating electromagnetic spectrum to private microwave users. In 1959, the FCC investigation concluded with a decision to permit large users to build private microwave systems.[22]

In 1969, the FCC issued a decision permitting a new company, Microwave Communications Inc. (MCI), to operate an interstate radio communications link between St. Louis and Chicago and lease private line services to business users in direct competition with AT&T.[23] Although the MCI decision was narrow in scope, granting authority to only one company, it opened a floodgate of new license applications.[24] In 1971, the FCC broadened the scope of the MCI decision in its Specialized Common Carrier Ruling.[25]

When the FCC allowed specialized carriers to enter the communications market, a new set of national carriers emerged that were not affiliated with major sources of telephone equipment. Consequently, opportunities for domestic and foreign suppliers of communications equipment emerged in a market previously controlled by AT&T. However, the new communications carriers were demanding customers, desiring advanced, innovative products and equipment that would differentiate their own services from those of AT&T. Therefore, for new equipment suppliers to succeed in the U.S. market, it was absolutely necessary that they be able to provide such new technology.

Although AT&T's Bell Labs continued to develop new basic technologies, especially in the area of microelectronics, the company delayed the introduction of new technological advances into its own networks.[26] Meanwhile, some foreign companies such as Alcatel in France and Northern Telecom in Canada were able to benefit from AT&T's basic research in digital technology to develop advanced digital switching systems, which they introduced into the market before AT&T. When Northern Telecom introduced a digital central office switch in the U.S. market in 1979, even local operating companies of AT&T began purchasing switches from the Canadian-based company since digital switches were not available from AT&T.[27]

One of the most significant events for long distance telephony occurred with the development of fiber optics as a commercially viable transmission medium during the 1970s and 1980s. Although AT&T's Bell Laboratories was integrally involved with some developments in this area, Corning Glassworks, a non-telecommunications firm, was chiefly responsible for developing and patenting optical fiber capable of efficiently transmitting voice, video, and data over long distance networks.[28]

---

[21] North American Telecommunications Association, *Industry Basics: Introduction to the History, Structure and Technology of the Telecommunications Industry*, Washington DC, 1989, p. 2.

[22] Crandall, p. 19.

[23] *Microwave Communications, Inc.*, 18 FCC 2d 953 (1969).

[24] NATA, *Industry Basics*, p. 3.

[25] *Specialized Common Carrier Service*, 29 FCC 2d 870 (1971).

[26] Kenneth Flamm, "Technological Advance and Costs," *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, edited by Robert W. Crandall and Kenneth Flamm, (Washington, DC: Brookings Institution, 1989), pp. 24 and 25.

[27] Jerry A. Hausman and Elon Kohlberg, "The Future Evolution of the Central Office Switch Industry," *Future Competition in Telecommunications*, edited by Stephen P. Bradley and Jerry A. Hausman (Boston: Harvard Business School Press, 1989), p. 197.

[28] Harvey Blustain, Richard Guenther, John Lawlor, and Paul Polishuk, *U.S. Long Distance Fiber Optic Networks: Technology, Evolution, and Advanced Concepts*, Vol. II, prepared for National Aeronautics and Space Administration (Boston, MA: IGI Consulting, Inc.), pp. 11 and 12.

Technological, regulatory, and economic developments during and after World War II had converged to bring a greater degree of competition into the previously monopolized communications services and equipment markets in the United States:

> During the years before [the war], few competitors could seriously challenge Bell's technological dominance, and those who could found regulators who weren't willing to let competitors distract Bell from its mission of achieving universal service. After [the war], more competitors had the technical wherewithal to challenge Bell in its markets, they had more reason to want to compete, and they found regulators willing to experiment cautiously with competition, now that universal service was within reach.[29]

The AT&T Breakup

Despite postwar developments, consumers of communications services and equipment, new competitors, and AT&T itself remained dissatisfied.[30] AT&T was dissatisfied with its exclusion from the data processing services and computer equipment markets by the 1956 Consent Decree, which strictly limited its activities to the common carrier communications services and equipment market. This limitation was particularly disturbing to the company because technological advances were blurring the boundaries between regulated communications activities and more competitive computer services and equipment fields. Foreign manufacturers of computers and electronics equipment, particularly in Japan, were increasingly gaining stature in communications markets.

On the other hand, potential competitors were dissatisfied with their inability to enter the communications market. Furthermore, users were disturbed by AT&T's apparent unresponsiveness to their needs and by a pricing structure that did not reflect the actual cost of providing services.[31] For example, long distance rates were set artificially high to help minimize increases in local rates. In addition, business users were charged more than residential customers for access and local exchange service.[32]

This dissatisfaction was the background of a 1982 agreement by AT&T to settle a suit filed by the Justice Department charging that AT&T had violated the Sherman Act by monopolizing interstate communications services and the market for communications equipment. In its complaint, the Department sought the divestiture of Western Electric and Bell Laboratories from AT&T. The settlement resulted in a breakup of the Bell System and completely restructured the communications industry, by means of a modification of the 1956 Consent Decree between AT&T and the Justice Department.[33]

In the settlement, known as the Modification of the Final Judgment (MFJ), AT&T agreed to divest its local telephone service operating companies on January 1, 1984 (figure 2-3). However, AT&T would retain Western Electric, Bell Labs, and its long distance service operations. To eliminate the vertical monopoly exercised by the captive equipment supply arrangement between Western Electric and local operating units, the agreement limited the newly independent Bell operating companies to local telephone services. The divested companies, reorganized as Regional Holding Companies (RHCs), could not offer long-distance service outside of their local access and transport areas (LATAs), engage in the manufacture of equipment, or offer content-based information services.[34] However, the MFJ allowed AT&T to enter other businesses, such as computers, and permitted the company to enter international markets for communications and other types of equipment.

Foreign Market Developments

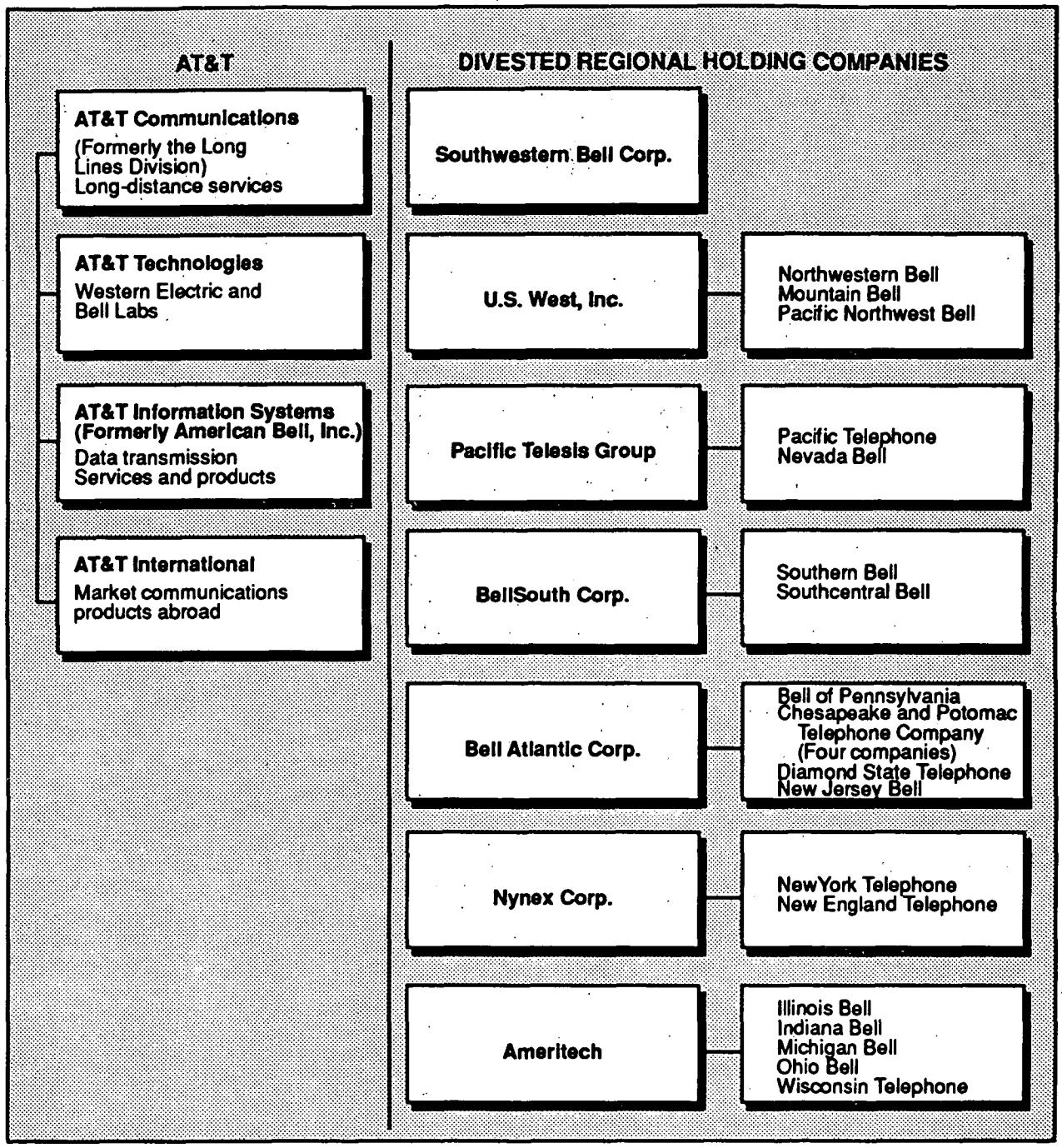
Parallel developments in the liberalization of communications markets occurred in other countries during the 1980s. The most dramatic of these were in the United Kingdom and Japan. In the United Kingdom, increased pressures from business consumers for more advanced communications services led to a complete restructuring after the conservative Thatcher government took office in 1979.[35] Restructuring was based on two partly conflicting policy goals: to encourage the service sector and reverse the decline of British technological leadership.[36]

Five elements of the new government policy included—

1. A formal separation of telecommunications from the Post Office and the establishment of British Telecom (BT) as an independent but regulated entity,
2. Establishment of competition in services by allowing rival carriers and value-added network services,
3. Privatization of the public network by selling a majority of British Telecom,

[29] Faulhaber, pp. 34 and 35.
[30] Blustain, Guenther, Lawler, and Polishuk, pp. 71 and 72.
[31] Ibid.
[32] Crandall, p. 23.
[33] Ibid p. 38.
[34] Ibid. p. 9. On July 25, 1991, a U.S. District Court order lifted the information restrictions on the BOCs.
[35] Eli M. Noam, "Telecommunications in Transition," *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, edited by Robert W. Crandall and Kenneth Flamm, (Washington, DC: The Brookings Institution, 1989), pp. 265-268.
[36] Ibid., pp. 265 and 266.

Figure 2-3
AT&T after divestiture



Source: Compiled by staff of the U.S. International Trade Commission.

4. Liberalization of the market for peripheral equipment, and

5. Establishment of the regulatory body Oftel.[37]

To give a competitive push to the newly privatized British Telecom, the government encouraged Cable and Wireless (C&W), British Petroleum (BP), and Barclay's Merchant Bank to form an alternate long-distance communications network in 1982.[38] This consortium, Mercury Communications Ltd., was modeled to a certain degree after MCI Telecommunications Corp., which was competing with AT&T in the United States.[39]

In Japan, similar pressures mounted in the early 1980s.[40] Demands from Japanese business users, international developments, such as the AT&T breakup and the British liberalization measures, and other external factors combined to produce forces for change in the Japanese communications system. Before World War II, both communications and postal services had been supplied by the Japanese Ministry of Communications. However, after the war a public corporation, NTT, was created as a public monopoly to develop the telecommunications industry. The Ministry of Communications, renamed the Ministry of Posts and Telecommunications (MPT), maintained regulatory control over NTT.[41]

In 1985, two major laws for restructuring the Japanese communications industry were enacted by the Japanese Diet. One, the NTT Corporation Law, set the stage for privatization of the old public corporation. The other, the Telecommunications Business Law, mandated a radical reconstruction of the industry, allowing competitors to enter the market.[42] Three new entrants, or new common carriers, Japan Telecom Co., Teleway Japan Corp., and Daini-Denden Inc. were the first to enter the market as competitors to NTT. At first they offered only private-line services, but more recently they have begun to supply public telephone services. Some industry observers viewed the Japanese market reform as a consequence of actions of U.S. policymakers. Despite the 1980 U.S.-Japan agreement on NTT procurement, pressure from the United States on the Japanese government to open up NTT's procurement process to foreign suppliers continued to mount in the early 1980s. This pressure escalated after the 1984 breakup of AT&T, which led to new market opportunities for foreign firms, including Japanese suppliers, in the liberalized U.S. market. U.S. trade officials suggested that a similar breakup of NTT might result in increased opportunities for suppliers outside the "NTT Family."

However, most industry observers and scholars agree that Japan had its own motives for restructuring its telecommunications industry.[43] During the late 1970s and early 1980s, the pressures on the government from private industry grew, demanding the privatization of government-owned monopolies such as the railroads, tobacco, and communications to increase efficiency.[44] Moreover, emerging Japanese industrial firms were concerned about NTT's domination of enhanced services, arguing that NTT should be confined to basic services. NTT, however, was prepared to give up its monopoly in return for the opportunity to provide more profitable enhanced services, having successfully fulfilled its previous mission of satisfying universal telephone service in Japan.[45] Other ministries, such as MITI, also pushed privatization and liberalization because they believed that the then monopoly communications market structure thwarted innovation and dampened opportunities for rapidly growing Japanese manufacturers of electronics and communications equipment.[46]

Germany and France have also implemented a number of major communications policy changes. In April 1989, the German telecommunications authority was legally restructured.[47] The restructuring also opened the terminal equipment market to approved suppliers, including foreign suppliers. This market was further liberalized by a law passed in July 1990, to no longer require the purchase of the first telephone set from the telecommunications authority.[48] Given Germany's reputation as one of the most restrictive telecommunications environments in the world, the recent changes represent major reforms.[49] France has adopted similar changes. Despite these changes, however, French and German telecommunications authorities retain government monopolies over basic communications services and, consequently, significant power and control over their communications markets.

---

[37] Ibid., pp. 265 and 266.

[38] Ibid., pp. 265-268.

[39] Ibid., pp. 265 and 266.

[40] Tsuruhiko Nambu, Kazuyuki Suzuki, and Tetsushi Honda, "Deregulation in Japan," *Changing the Rules: Technological Change, International Competition, and Regulation in Communications* (Washington, DC: The Brookings Institution, 1989), p. 148.

[41] Ibid.

[42] The Business Law divided the telecommunications sector into two categories of companies: type I and type II. Type I carriers were allowed to own and operate their own networks while type II carriers were limited to providing enhanced (or value-added) services over leased lines.

[43] Interviews by USITC staff with Japanese government and industry officials in Tokyo, Japan; Johnson, *MITI, MPT, and the Telecom Wars*, Nambu, Suzuki, and Honda, "Deregulation in Japan;" and interview by USITC staff with Gene Gregory, Sophia University, Tokyo on May 1, 1991.

[44] Gene Gregory.

[45] Y. Ito, "Telecommunications and Industrial Policies in Japan: Recent Developments," edited by M.S. Snow, *Telecommunications Regulation and Deregulation in Industrial Democracies*, (Amsterdam: North-Holland, 1986).

[46] Gene Gregory interview.

[47] NATA *EuroTelecom 1992*, Washington, DC: 1990, p. 57.

[48] Ibid.

[49] National Telecommunications and Information Administration, *NTIA Telecom 2000: Charting the Course for a New Century* (Washington, DC: U.S. Department of Commerce, October 1988), p. 42.

Although other European countries have generally liberalized more slowly, the European Commission (EC) has increased pressure on its members' national telecommunications authorities to liberalize communications markets as part of EC integration. An EC "Green Paper" released in 1987 called for harmonizing European communications standards and somewhat greater competition in certain market sectors, including communications equipment, in preparation for the reduction of all EC trade barriers in 1992.

Current Profile of the Global Industry

Production and consumption of communications equipment is currently concentrated in a few developed countries. However, the growth in these markets is slowing, and producers are seeking ways to reduce costs and increase sales. As a result, some have moved production to other countries to take advantage of lower wages. Others seeking to gain foreign market share set up local facilities in some developing countries because local production has become a prerequisite to sales. For these and other reasons explained below, the industry is becoming more globalized.

Structure of Production

In 1990, worldwide production of communications equipment reached nearly $64 billion (table 2-1). About 74 percent of world communications equipment production originates in the MEP countries of Canada, France, Germany, Japan, Sweden, the United Kingdom, and the United States. Of these seven nations, Japan and the United States are clearly the largest producers. Although production in the other MEP countries generally grew at a faster rate than did U.S. production during 1984-90, production in individual countries is relatively small. When the European Community is viewed as a whole, its share of switching production is substantial, but its ranking in terminal and transmission production is expected to remain a distant third behind the United States and Japan (figure 2-4).

Worldwide, major producers of network equipment, especially of large switching equipment, number less than a dozen. Nearly all of these producers are multinational firms headquartered in developed countries. Terminal equipment, on the other hand, is manufactured by these multinational companies and by thousands of small and medium-sized businesses throughout the world. Producers of transmission equipment are many and diverse. Sophisticated transmission equipment is produced principally in MEP countries by both small, specialized high technology firms and large multiproduct, multinational firms. Lower technology transmission equipment is produced throughout the world by all sizes of firms, many of which produce electrical products.

An increasing amount of production takes place in nations other than the seven largest equipment producers, particularly in the nations of the Far East. This production is often carried out by subsidiaries of multinational firms headquartered in MEP nations. AT&T, for example, manufactures telephones in Singapore; Fujitsu manufactures switches in Thailand; and Northern Telecom manufactures components in Malaysia. The internationalization of production in recent years is due to three major trends in the industry: increased business alliances between major producers, creation of new equipment markets by liberalization, and transfer of terminal equipment production and technology to low-wage nations in the Far East.

Business alliances, including mergers, acquisitions, and joint ventures, have increased as product development costs have grown, particularly in the network segment of the industry. In order to recoup these costs, major network manufacturers must gain a significant portion of the world market in addition to maintaining large shares in home markets. Joint ventures and acquisitions have increased in recent years as companies use these methods to enter foreign markets. Moreover, many acquisitions have taken place because companies find it less expensive to buy a product line or brand name than to develop one independently.

As the regulation of communications services becomes more liberalized in many countries, competition—and the number of suppliers—is growing. This growth has increased demand for both network and terminal equipment as consumers of communication services construct their own networks to reduce costs and customize services. The increase in demand has given rise to a large number of small and medium-sized firms that design systems and sell equipment to private companies and individuals rather than to telephone companies. In addition, many firms have entered the industry to supply new cellular and value-added services.[50]

Stiff price competition from lower cost producers and changing technology are also altering the makeup of the industry. Although major North American, European, and Japanese firms are still involved in the production of sophisticated telephone systems for the business market, they have largely shifted production of high-volume consumer terminal equipment to low-wage countries in the Far East. Manufacturers in these countries, either as subsidiaries of or suppliers to the multinational communications equipment producers, have come to dominate the consumer market for terminal equipment, particularly residential telephone sets, key systems, and answering machines.

The multinational companies shown in table 2-2 are the largest producers of switching and network equipment in the world. Most of these companies are also diversified into a broad range of other communications products, including microwave and satellite communications devices, mobile radio

[50] Value-added services add some form of processing or information to a communications signal. Typical value-added services are stock market quotation services and electronic mail.

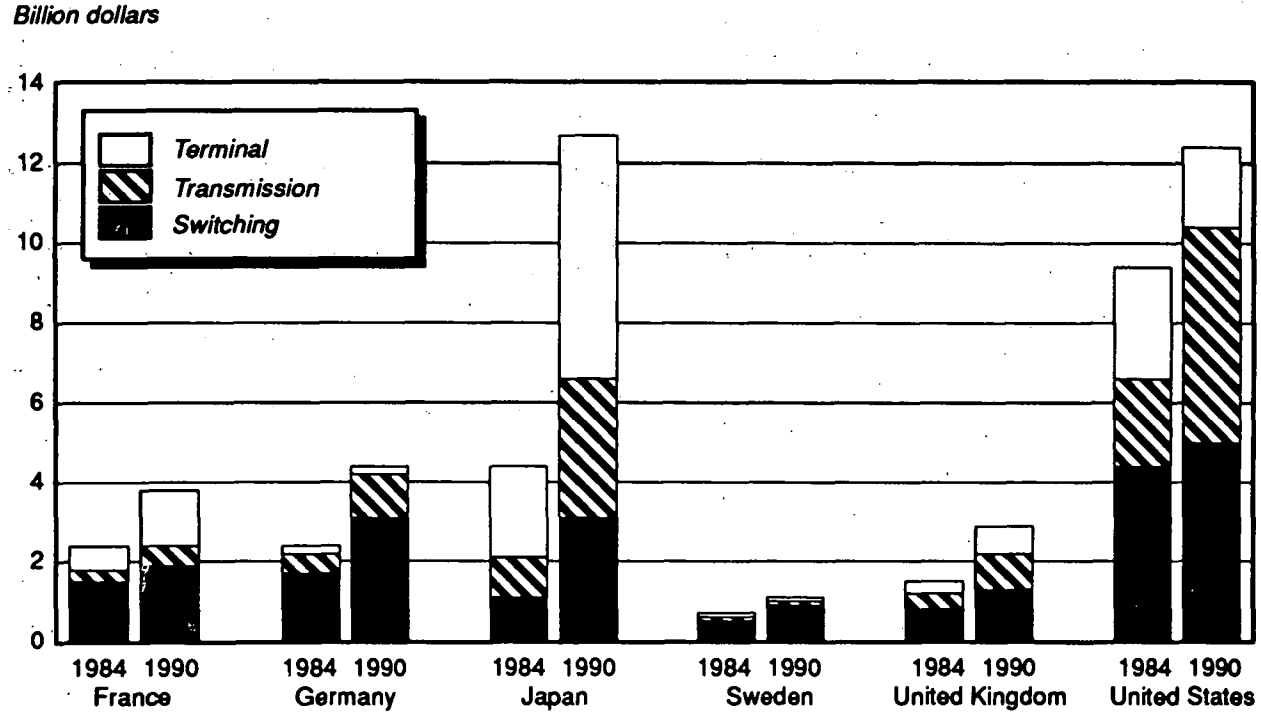
Table 2-1
Production of communications equipment, by country, 1984–90
(Millions of dollars)

Country	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*
Canada	1,402	1,351	1,319	1,451	1,650	1,776	1,818
France	3,001	3,054	4,050	4,689	4,698	4,474	4,576
Germany	2,885	3,294	3,981	4,806	4,946	4,723	4,835
Japan	5,521	6,071	8,669	11,497	14,727	14,015	14,015
Sweden	1,142	1,295	1,421	1,380	1,683	1,669	1,702
United Kingdom	1,969	2,040	2,378	2,505	3,271	3,156	3,179
United States	15,103	16,936	15,825	16,429	16,751	16,770	16,830
Total	31,023	34,041	37,643	42,757	47,726	46,583	46,955
All other	7,637	7,939	10,096	12,715	14,776	15,661	16,651
World total	38,660	41,980	47,739	55,472	62,502	62,244	63,606

Note: 1990 values are estimated in constant 1989 dollars.

Source: Elsevier Profile of the Worldwide Telecommunications Industry.

Figure 2-4
Communications equipment production in selected countries, by product line, 1984 and 1990



Note.—Data do not include parts.

Source: Elsevier Profile of the Worldwide Telecommunications Industry.

Table 2-2
Revenue of the major communications equipment manufacturers, 1987

Headquarters Location	Company Name	Total Revenue	Communication equipment revenue	Communications equipment revenue as a percentage of total revenue
		— Million dollars —		Percent
North America	AT&T[1]	33,768	13,938	41
	GTE[2]	16,923	2,200	13
	Motorola	5,962	3,100	52
	Northern Telecom	4,800	4,800	100
Europe	Alcatel	10,380	8,200	79
	Ericsson	3,667	3,300	90
	GPT	12,105	2,300	19
	Siemens	21,250	5,100	24
Japan	Fujitsu	10,000	1,600	16
	NEC	12,813	4,100	32

[1] Communications equipment revenue for AT&T includes revenue for data systems and rentals. Total revenue includes service revenue.
[2] GTE no longer manufactures communications equipment.

Source: OECD, "Telecommunications Equipment: Changing Markets and Trade Structures," ICCP report #24, t ables II-2 and II-6; and AT&T, *Annual Report for 1989,* p. 21.

systems, messaging and voice mail systems, and fiber optics. Switching equipment typically accounts for one-third to one-half of communications equipment producers' revenues.

The U.S. communications equipment industry is still dominated by AT&T, which has been able to maintain a substantial share of the U.S. market since divestiture. Northern Telecom, a subsidiary of Bell Canada, is AT&T's largest competitor in the U.S. market. Since 1984, the two firms have accounted for more than 80 percent of the market for digital central office switching equipment, the largest segment of the communications equipment market.[51] Both firms operate in every segment of the communications equipment industry and compete globally with the other major equipment producers.

The European and Japanese markets are also dominated by just several full-scale equipment producers. The two largest communication equipment manufacturing firms in Europe are Alcatel and Siemens, estimated to account for 40 to 50 percent of total EC production.[52] Another major European player in world markets is L.M. Ericsson of Sweden. Although Ericsson manufactures various network and switching equipment, its current strength is cellular communications equipment and systems. The Japanese communications equipment industry is dominated by NEC and Fujitsu, which have traditionally supplied a major portion of the network switching, transmission, and terminal equipment needs of NTT, the principal telephone and communications service operator in Japan.

[51] Crandall, p. 85.
[52] "Telecommunications Equipment," *Panorama of EC Industry - 1989,* p. 12-8.

Many of the major manufacturers of communications equipment derive less than half of their revenue from sales of such equipment, as can be seen in table 2-2. Some Asian and European suppliers of communications equipment are major electronics firms that diversified into various segments of the communications industry. Sales of electronic products other than communications equipment account for a major portion of these companies' revenues. In contrast, the nonservice revenues of the two major North American firms, AT&T and Northern Telecom, are almost entirely from communications equipment sales and rentals. AT&T's service revenues account for the remainder of its total sales. Several Japanese and European members of the industry have succeeded in diversifying into computers, more so than have North American players. However, only very few communications equipment producers have been able to maintain a leading position in computer technology.[53]

In addition to full-line suppliers described above, a handful of smaller, often regionally oriented firms, such as General Electric Corp. (GEC)[54] and Plessey[55] in the United Kingdom, Hitachi and OKI in Japan, and Stromberg-Carlson and GTE[56] in the United States, have provided some competition to the larger players. However, many of these companies have been losing

[53] Noam, p. 262.
[54] GEC is not related to the U.S.-based General Electric Co.
[55] In 1989, GEC bought 60 percent of Plessey and Siemens of Germany bought the remaining 40 percent to form GEC Plessey Telecommunications Ltd. (GPT). Andrew Collier, "Siemens Seeks Switch Scheme Tie," *Electronic News,* March 18, 1991, p. 12.
[56] GTE sold its equipment-producing operations in the late 1980s.

market share and some, such as GTE, have sold their manufacturing operations, whereas others have merged with stronger firms. These mergers and divestitures are part of the current trend toward consolidation among major suppliers of network equipment.

Major international players also face competition from smaller firms in other segments of the communications equipment industry. A fiercely competitive market for PBXs has brought major network equipment producers, such as AT&T, Northern Telecom, NEC, and Siemens, into competition with niche producers, such as Mitel and Intecom.[57] Firms such as Motorola and Corning Glassworks of the United States have emerged as leading suppliers of cellular radio and fiber optic transmission systems, respectively, which are competing with, and even replacing, traditional communications network systems based on copper and coaxial cable.[58] At the same time, firms such as Harris, MA-Com (Hughes), Rockwell, and Telettra[59] dominate the market for microwave transmission equipment.

In addition to these firms, other less diversified communications companies specialize in certain types of transmission equipment, such as copper and fiber optic cable, satellites, and microwave transmitting and receiving equipment. There is also a large number of companies manufacturing a wide range of components for communications and other electronic equipment, such as transmitters, connectors, and multiplexers. In some cases, small entrepreneurial firms, such as Lasertron in the United States, have driven the technology and commercialization of laser-based fiber optic transmitters and receivers.

Structure of Trade

In 1984, total imports into the major equipment-producing countries amounted to less than $4 billion, out of roughly $6.1 billion worldwide (table 2-3). By 1988, the MEP countries accounted for $8.2 billion in communications equipment imports, while imports into all other nations had risen to about $5.0 billion.

In most MEP countries, imports of communications equipment consist primarily of low-technology terminal equipment which is often imported from offshore subsidiaries of domestic manufacturers. MEP nations' imports increased considerably during 1984-88. The bulk of this increase was imports of relatively low technology terminal equipment, that business and residential consumers began buying once market liberalization steps were introduced in the MEP countries (see figure 2-5). The United States had the highest imports during this period, and in 1988, U.S. imports of this equipment were greater than the other MEP countries' imports combined.

Producers based in the MEP nations expanded exports during 1984-88, and established themselves as key suppliers in many growing markets during this time (table 2-4). Producers in relatively small markets such as Canada and Sweden depend on exports to recoup their research and development (R&D) costs and enable them to achieve scale economies in production. Japan and the United States were the largest exporters during this period, as these two nations accounted for 65 percent of all MEP communications equipment exports in 1988. The exports of Germany and Sweden also rose consistently during this period. In general, terminal equipment experienced the highest growth in MEP nations' exports, although Sweden, Japan, and the United States also had significant increases in exports of switching equipment (see figure 2-6). The vast increase in Japanese exports of terminal equipment was partially a result of facsimile machines exports, which have risen worldwide since their introduction in the early 1980s.

The closed nature of many communications equipment markets is demonstrated by the import-to-consumption ratios shown in figure 2-7. The data indicate that government-owned or controlled telecommunications authorities in Europe, Japan, and most of the rest of the world still overwhelmingly favor domestic suppliers. For example, industry experts in Japan estimate that four domestic firms, NEC, Fujitsu, Hitachi, and OKI supply roughly 80 percent of NTT's switching and transmission equipment purchases.[60] The percentage of domestically supplied equipment in the public network is estimated at 85 to 100 percent in most major-equipment producing nations.[61] National preferences in procurement and technological requirements for compatible equipment have led to the development of a nearly impenetrable embedded base of communications equipment in most nations. Of the major equipment-producing countries, the United Kingdom and the United States have by far the highest import levels. This is one indication that efforts to liberalize market access are more advanced in these two nations than in others.

---

[57] Lamont Wood, "Ringing Up New Business With PBXs," *Datamation*, Aug. 15, 1990, pp. 75-77.

[58] Even manufacturers of relatively new technologies such as satellite communications equipment are concerned that high-capacity undersea fiber optic cable may affect the future demand for satellites in international communications. John Burgess, "AT&T, Japanese Firm to Lay High-Capacity Pacific Cable," *Washington Post*, Oct. 18, 1990, p. D1; *U.S. Long Distance Fibre Optic Networks: Technology, Evolution and Advanced Concepts*, prepared for NASA Lewis Research Center by IGI Consulting Inc. Boston, MA, October 1986; and *Satellites and Fibre Optics: Competition and Complementarity* (Paris: Organization for Economic Cooperation and Development, 1988).

[59] Alcatel of France acquired a 78-percent stake in Telettra of Italy. Andrew Hill, "Brussels Imposes Strict Conditions on Merger," *Financial Times*, April 13-14, 1991, p. 22.

[60] Government and industry officials interviewed by USITC staff during fieldwork in Japan, June 1990.

[61] Government and industry officials interviewed by USITC staff in Washington, DC, and Europe, February - May 1991.

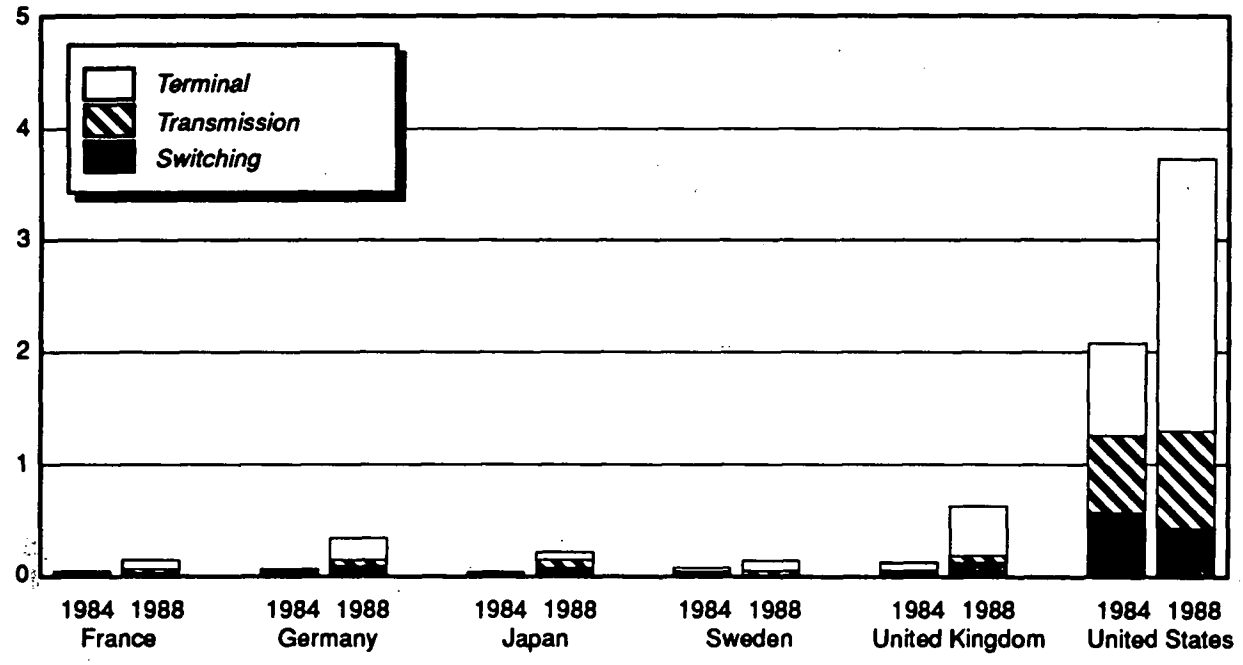
Table 2-3
Imports of communications equipment, by country, 1984-1988
(Millions of dollars)

Country	*1984*	*1985*	*1986*	*1987*	*1988*
Canada	208	209	227	290	437
France	81	87	102	166	266
Germany	129	163	235	431	609
Japan	88	117	160	248	375
Sweden	123	150	200	202	260
United Kingdom	311	413	534	844	1,130
United States	2,987	3,296	3,872	4,392	5,134
Total	3,927	4,435	5,330	6,573	8,211
All other	2,191	2,465	2,940	3,694	4,976
World total	6,118	6,900	8,270	10,267	13,187

Note.—Data do not include imports of nonmarket economy countries.

Source: Elsevier Profile of the Worldwide Telecommunication Industry.

Figure 2-5
Communications equipment imports into selected countries, by product line, 1984 and 1988



Note.—Data do not include parts.

Source: Elsevier Profile of the Worldwide Telecommunications Industry.

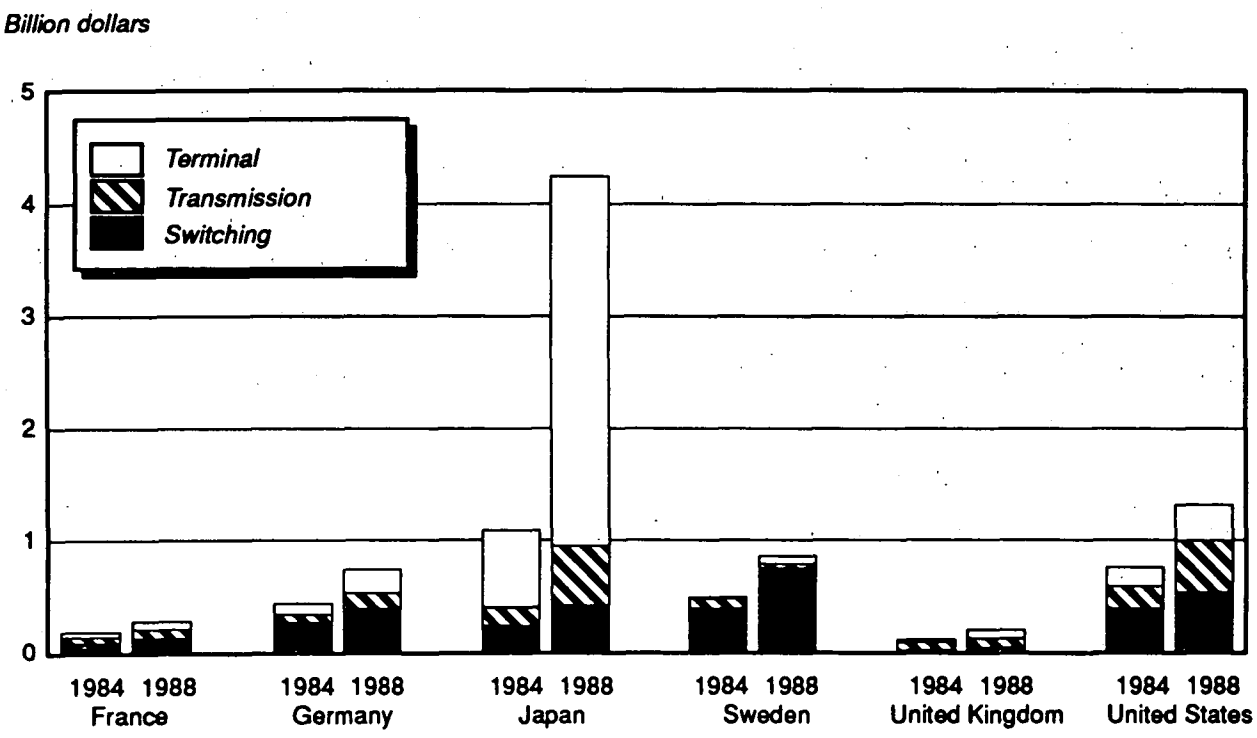
Table 2-4
Exports of communications equipment, by country 1984-88
(Millions of dollars)

Country	*1984*	*1985*	*1986*	*1987*	*1988*
Canada	648	620	532	579	609
France	428	462	482	552	605
Germany	661	747	937	1,312	1,267
Japan	1,710	1,837	2,343	3,331	5,148
Sweden	838	962	969	945	1,250
United Kingdom	245	310	321	390	473
United States	1,532	1,648	1,881	2,193	2,711
Total	6,062	6,586	7,465	9,302	12,063
All other	1,922	1,934	2,742	3,594	4,150
World total	7,984	8,520	10,207	12,896	16,213

Note.—Data do not include exports of nonmarket economy countries.

Source: Elsevier Profile of the Worldwide Telecommunications Industry.

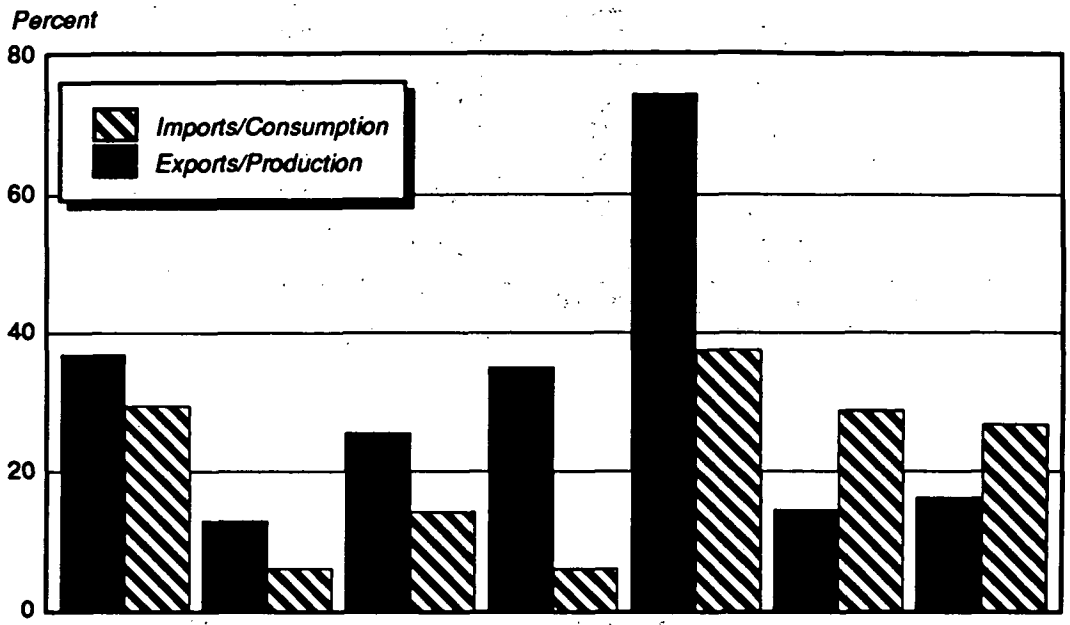
Figure 2-6
Communications equipment exports from selected countries, by product line, 1984 and 1988



Note.—Data do not include parts.

Source: Elsevier Profile of the Worldwide Telecommunications Industry.

Figure 2-7
Export and Import ratios for communications equipment, by country, 1988



	Canada	France	Germany	Japan	Sweden	United Kingdom	United States
Exports/Production	37%	13%	26%	35%	74%	14%	16%
Imports/Consumption	30%	6%	14%	7%	38%	29%	27%

Source: Elsevier Profile of the Worldwide Telecommunications Industry.

Structure of the Market

Apparent consumption of communications equipment increased by more than 50 percent in the MEP nations during 1984-90, as shown in table 2-5. The United States is the largest market in the world for this equipment with annual consumption of nearly $20 billion in 1990. Among the nations with the highest rates of growth in communications equipment consumption are those that have liberalized regulatory policies, such as the United Kingdom and those that are modernizing and expanding networks, such as Japan. Apparent consumption of communications equipment in Japan increased more than 150 percent compared with less than 20 percent in the United States during this period, although U.S. consumption remained twice that of Japan's in 1990. Consumption in all other nations also rose significantly in the 1980s, as these nations modernized their telecommunications infrastructure.

Consumption by type of communications equipment varies among the MEP countries, as is shown in figure 2-8, and is affected by regulations as well as communications infrastructure improvements. In Japan, consumption of switching and transmission equipment increased significantly during 1984-1990, reflecting extensive network modernization and expansion efforts. A similar but smaller increase occurred in Germany as well. Liberalization of terminal equipment regulations is evidenced by its share of consumption. In all countries except Germany, terminal equipment constitutes a significant proportion of total consumption. In Germany, where restrictions on individual ownership of telephone sets were just recently removed, consumption of terminal equipment was less than 10 percent of total consumption in 1990.

Within each market, the largest consumers of communications equipment are operators of national and regional telephone services. In the United States, these operators consist of many private local and long distance service providers.[62] In most other countries there is only one provider, the government telecommunications authority. Although some

[62] While the regulated carriers in the United States remain the principal purchasers of communications equipment, private business networks accounted for an estimated 19 percent of telecommunications net capital investment in 1988. Further, total spending on private systems by government and business was estimated at 29 percent of spending on telecommunications capital in 1988. Robert W. Crandall, pp. 47-48.

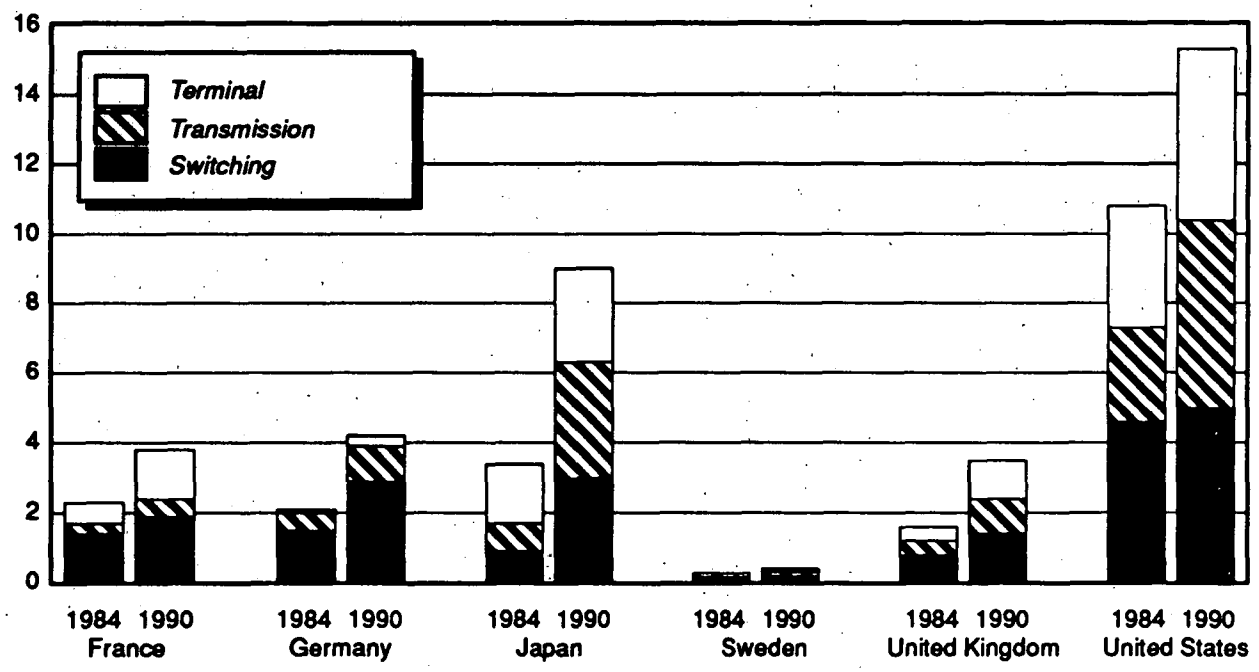
Table 2–5
Apparent consumption of communications equipment, by country, 1984–90
(Millions of dollars)

Country	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*[1]
Canada	962	942	1,014	1,162	1,479	1,598	1,649
France	2,654	2,679	3,670	4,303	4,359	4,278	4,403
Germany	2,354	2,710	3,279	3,925	4,288	4,282	4,427
Japan	3,899	4,347	6,485	8,414	9,953	9,623	9,739
Sweden	427	483	651	637	693	678	691
United Kingdom	2,035	2,143	2,591	2,959	3,929	3,823	3,902
United States	16,558	18,584	17,816	18,628	19,174	19,800	19,800
Total	28,889	31,888	35,506	40,028	43,875	44,082	44,611
All other	9,771	10,092	12,233	15,444	18,627	18,162	18,995
World total	38,660	41,980	47,739	55,472	62,502	62,244	63,606

[1] 1990 values are estimated in constant 1989 dollars.
Source: Elsevier Profile of the Worldwide Telecommunications Industry.

Figure 2-8
Communications equipment consumption in selected countries, by product line, 1984 and 1990

Billion dollars



Note.—Data do not include parts.
Source: Elsevier Profile of the Worldwide Telecommunications Industry.

countries, such as the United Kingdom and Japan, have licensed other companies to compete with their dominant national carriers in recent years, in general, communications services and equipment purchases are still largely under government control.

Deregulation and technological advances have opened up new markets for communications equipment. In emerging technologies, such as cellular communications, the drive to establish overlay mobile networks in competition with the dominant wire-line telephone networks is prompting major investments in cellular and mobile communications equipment.[63] Regulatory change has lessened the dominant service monopolies' control over supply of equipment to the user and has made businesses and households important new consumers. Liberalization of the communications services industry has created a new group of network-bypass,[64] value-added, and other specialized service providers, which are proving to be a growing market for communications equipment, especially fiber optic transmission systems.[65]

Economic growth in developing countries, particularly in newly industrialized countries of the Far East and East Bloc countries, is expected to drive demand for communications equipment in these countries. The rapidly developing economies in eastern Asia are planning substantial investment in supporting infrastructure, including communications. The Governments of China and India are restructuring communications systems to meet the increasing demands placed on telecommunications networks as these countries modernize.[66] Similar efforts are under way in developing countries throughout the world as well as in the Soviet Union and Eastern Europe, where modernization of the communications infrastructure is often part of government economic incentive programs to attract foreign investment.[67]

Trends in Technology

Digital technology has virtually revolutionized communications equipment. Modern communications systems use digital technology rather than analog technology because digital is faster and more reliable. Digital technology configures all signals, both voice and data, so that they appear identical to the system, permitting these digitized signals to be broken up into separate "packets" that are transmitted along with packets from other calls. For example, the "dead air" between spoken words during a telephone call can be filled with packets transmitting computer data. On the receiving end of the transmission, the individual packets are reassembled into the original message. Time-division switching allows more efficient use of available signal paths since more than one message may go over the same path.[68] In addition, communication between computers is easier and more reliable because computers handle and exchange data in digital form.

Other technological changes have increased the speed, versatility, and capacity of communications equipment. Central office switches using older technology mechanically translated the numbers that a customer dialed into a fixed path through the network. Today, a reprogrammable computer reads the caller's routing instructions electronically, factors in current communications traffic, and transmits the signal over the optimal path. The result is faster connections and fewer busy circuits.

The replacement of copper cable with microwave relay, satellite communications, and fiber optic cable systems geometrically advances the amount of information that communications systems can carry. Current commercial transmission systems can carry about 1.7 billion bits of information per second—roughly 26,000 phone calls—on a pair of glass fibers no bigger than a strand of hair.[69]

Linkages to Other Sectors of the Economy

The communications equipment industry is intimately linked to other sectors of the economy in two ways: upstream linkages to those industries that supply technology and components and downstream linkages to the industries that use communications equipment (see figure 2-9). Major upstream industries have reduced costs and increased the capabilities of communications equipment largely through innovations that have made possible the digitization of the network. At the same time, these enhancements have enabled downstream industries to provide new and improved services to their customers.

Upstream Linkages

Increased computing power and decreased costs of microelectronic components have had a significant impact on the development of the industry. The number of circuits on a semiconductor chip has increased from one to several million, and chips today are 10,000

[63] Fleming Meeks, "Where's the Bottom?: Cellular Phone Stocks Have Bombed. The Bad News Isn't Over," *Forbes*, Nov. 26, 1990, pp. 50-52.

[64] Bypass service companies establish private networks that connect business customers directly to long distance carriers and thereby bypass the local telephone companies' network and any resultant connection fees.

[65] Charles Siler, "How to Bypass Your Friendly Phone Company," *Forbes*, Aug. 21, 1989, pp. 88 and 89.

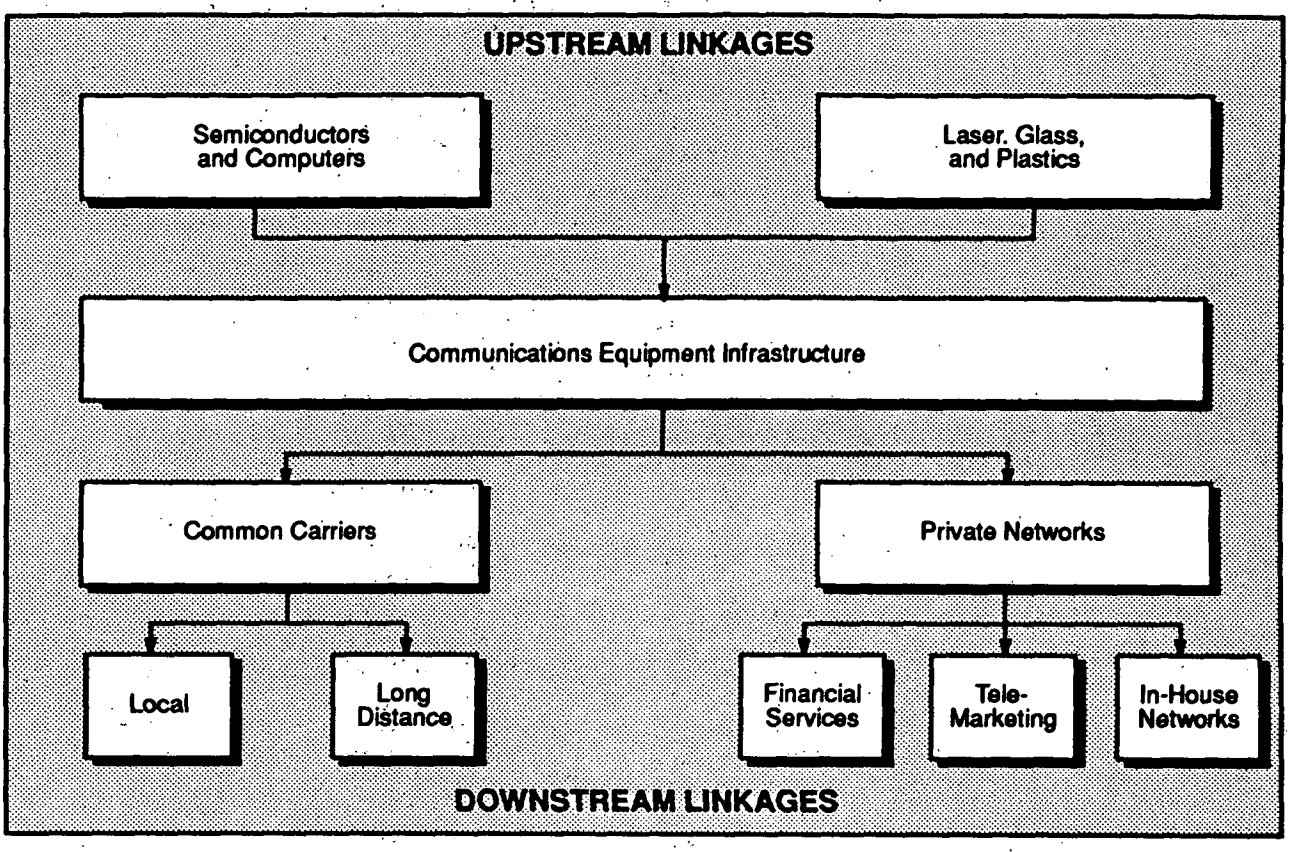
[66] Robert R. Bruce, Jeffrey P. Cunard, and Mark D. Director, "Telecommunications Structures in the Developing World: An Essay on Telecommunications and Development," *The Telecom Mosaic: Assembling the New International Structure* (United Kingdom: Butterworth, 1988), pp. 407-446.

[67] Kenneth S. Hoyt and Edgar Grabhorn, "Where Is the Money Going," *Telephone Engineer & Management*, Jan. 15, 1990, p. 50.

[68] U.S. Congress, Office of Technology Assessment, *Critical Connections: Communications for the Future*, OTA-CIT-407 (Washington, DC: GPO, January 1990), pp. 22-24.

[69] Ibid., p. 48.

Figure 2-9
Communication equipment industry linkages



Source: Staff of the U.S. International Trade Commission.

times more efficient than their predecessors.[70] Prices also have fallen, creating subsequent benefits for industries that use these components. By the end of this century, it is expected that there will be a density of one billion transistors per chip, allowing computers to operate at 100 million instructions per second, or 20 times their current rate.[71] Network and terminal equipment manufacturers will then be able to develop products with more advanced features. Advances in semiconductor technology have also contributed greatly toward miniaturization of printed circuit boards and other vital components of communications equipment, leading to increased standardization and economies of scale.

Some of the integrated manufacturers of communications equipment and other high-technology products have achieved economies of scale, and spread their R&D costs over a wider product line. Major communications equipment manufacturers such as Motorola, Fujitsu, and Siemens manufacture semiconductor components for in-house use and have used this experience to diversify into other upstream segments of the electronics industry. Although AT&T was prohibited from entering the computer market until 1984, many other companies, such as NEC, Siemens, and Fujitsu, have benefited from their experience in the computer industry, successfully transferring technology from other divisions to communications equipment operations.

Fiber optic technology has revolutionized the development of transmission equipment, dramatically improving transmission quality and speed. The capacity of a fiber optic cable is tremendous; in theory, three fiber optic lines could carry traffic from one-half the population of North America to the other.[72] Fiber optics also permit greater reliability of transmission equipment under adverse environmental conditions and are not subject to electromagnetic interference. Because the bandwidth, or carrying capacity, of fiber optic cable is much greater than that of copper cable,

[70] *Annual Report*, Cap Gemini Sogeti, 1989, p. 14.
[71] Ibid, p. 15.

[72] James Martin, *Telecommunications and the Computer* (Englewood Cliffs, NJ: Prentice Hall, 1990), p. 321.

more information—whether it be voice, video, or computer data—can be carried over the network, thereby improving network users' efficiency.

Downstream Linkages

Advances in communications technology have an important impact on other sectors of the economy making high-speed communication networks, capable of carrying voice, data, and video, essential in a modern society. Electronic communications technology has reduced the time and cost of functions once performed manually, such as transferring money, which now may be done through telephone lines. In addition, letters can be sent by facsimile machine or electronic mail, and video conferences can bring together people from different parts of the globe. These services, which rely on networks as a means of transport, are becoming more widespread and are among the fastest growing sectors of the communications services industry.

Many industries are increasingly dependent on advanced communications networks to be competitive in their respective markets. Financial service providers are among the biggest users of communications equipment. The Society for Worldwide Interbank Financial Telecommunication (SWIFT), one of the largest international banking networks in the world, connected 2,814 financial institutions in 67 countries and processed an average of 1.2 million transactions per day in 1989.[73] Because they demand such sophisticated communications applications, financial service companies have become laboratories for testing new communications systems.

Retail and merchant banks have become particularly reliant on the communications network to gain access to their customers and branches. All banks in the United States either maintain their own communications network or lease access to other national or international networks. Electronic funds transfer (EFT) has saved the banking industry both time and money, because processing paper checks is a very labor-intensive task. If an average of one day were taken off the time it takes to process each check, this would reduce the float, essentially an interest-free loan while checks are in transit, by about $54 billion per year.[74]

There are approximately 100,000 Automated Teller Machines (ATMs) in the United States, and at least half of them are connected to one of eight national communications networks.[75] In 1987, each ATM processed an average of 5,550 transactions a month, and it was estimated that the total value of all ATM transactions would be over $500 billion in 1990. ATM networks are also becoming more prevalent outside the United States. By accessing the PLUS ATM network, it is now possible for a person to use an ATM in the United Kingdom to withdraw funds from an account in the United States. The use of home banking is also increasing. By using a personal computer to access accounts via telephone lines, an individual can pay bills, purchase stocks, or transfer money between accounts. In the future, these banking services are expected to be as popular as ATMs, and may increase demand for new types of communications equipment.

The providers of third-party networks to groups of small firms or specialized industries, whose size does not warrant establishing private networks, are also important buyers of communications equipment. These third-party networks offer information and value-added communications services such as data base services, electronic mail, and electronic data interchange (EDI). Such applications of communications equipment have allowed corporations to track merchandise and exchange purchase and shipping orders electronically. Some of the largest third-party networks are owned by Electronic Data Systems, General Electric Information Services Corp., and Infonet.

Communications equipment plays an instrumental role in performing internal functions such as inventory control and intracorporate communications; internal communications account for 80 to 90 percent of an organization's total information volume.[76] To move this information, many large corporate users of communications services operate private networks and resell excess capacity to the public. Interconnection of computers enables companies to link commercial and manufacturing sites internationally using public and private telephone lines and to obtain faster and more efficient communications electronically rather than on paper. In the future, faster data transmission rates will enable computers separated by thousands of miles to transmit information between users in seconds.

An advanced communications infrastructure often serves as the backbone of the economy in developed countries. As society moves from an industrial to an information era, the communications equipment industry plays an even more vital role in facilitating commerce and enhancing productivity in both the manufacturing and service sectors. Developing countries as well increasingly seek to improve their communications network to attract investment and foster economic growth. An advanced communications network has thus become an important determinant of competitiveness in many sectors of the economy.

---

[73] Society for Worldwide Interbank Financial Telecommunication, *Annual Report, 1989*, Brussels, pp. 1 and 14.

[74] James Martin, p. 18.

[75] Ibid.

[76] Annual Report, Cap Gemini Sogeti, 1989, p. 27.

CHAPTER 3
VIEWS ON INTERNATIONAL COMPETITIVENESS

Introduction

This chapter introduces the factors that academic researchers, representatives of the industry, and the Commission believe influence competitiveness in this industry. Section 1 reviews academic research and other studies related to international competitiveness of the communications equipment industry.[1] However, the bulk of the literature tends to focus on the service sector, with only limited discussion of the determinants of international competitiveness of communications equipment suppliers. Section 2 presents the views of industry representatives on the influence of government policy and internal company policies on the competitiveness of the communications equipment industry. Information for this section was gathered during interviews with representatives of the industry in North America, Europe, and Japan. Finally, section 3 presents an overview of the framework used in this study to analyze the international competitiveness of communications equipment suppliers.

Review of Literature

The literature reviewed in this section[2] analyzes competitiveness in the communications equipment industry in two ways: (1) quantitative measures of the concept of competitiveness and (2) various factors that influence or determine competitiveness. The product focus of this literature is on the manufacture of customer-premises equipment (CPE) and central office (CO) switching equipment.[3] The determinants of competitiveness are different for these two product segments, and thus each segment will be discussed separately. However, an important determinant of competitiveness for the entire communications equipment industry is official export financing programs. This section also reviews two recent studies that describe the impact of these programs on the competitiveness of high-technology equipment exports.[4]

How International Competitiveness is Measured

The definition of competitiveness in the literature generally refers to a firm's achievement of long-term preeminence over rival firms through the ability and willingness to identify, adopt, and pursue successful market strategies in a rapidly changing technological and commercial environment. These market strategies involve product design and marketing, technical expertise, investment, manufacturing techniques, firm structure, and manpower development. Because competitiveness depends to a large extent on the ability of firms to respond to changes in the environment, it is a dynamic attribute that varies over time, rather than a static condition.

Although there seems to be a consensus on the definition of international competitiveness, the literature emphasizes that no single variable can adequately measure the competitiveness of firms in the communications equipment industry.[5] The literature

---

[1] Literature related to the competitiveness of nations in general is reviewed in appendix F.

[2] These studies include: Robert W. Crandall, *After the Breakup: U.S. Telecommunications in a More Competitive Era* (Washington, DC: The Brookings Institution, 1991); Gerald R. Faulhaber, *Telecommunications in Turmoil: Technology and Public Policy* (Cambridge, MA: Ballinger Publishing Co.,1987); Eli M. Noam, "International Telecommunications in Transition," *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, edited by Robert W. Crandall and Kenneth Flamm, (Washington, DC: The Brookings Institution, 1989); U.S. Department of Commerce, International Trade Administration, *The Competitive Status of the U.S. Electronics Sector; From Materials to Systems*, A report from The Secretary of Commerce to the Appropriations Committee, U.S. House of Representatives, Washington DC, April 1990; Jerry A. Hausman and Elon Kohlberg, "The Future Evolution of the Central Office Switch Industry," *Future Competition in Telecommunications* edited by Stephen P. Bradley and Jerry A. Hausman, (Cambridge, MA: Harvard University, 1989); Jerry A. Hausman, *An Economic and Regulatory Assessment of Joint Ventures, Strategic Alliances and Collaboration in Telecommunications*, presented at the Telecommunications Business and Economics Symposium, Massachusetts Institute of Technology, Cambridge, MA, Nov. 30, 1989; Peter F. Cowhey, "Telecommunications," *Europe 1992: An American Perspective*, edited by Gary C. Hufbauer, (Washington DC: Brookings Institution, 1990); E. Sciberras and B.D. Payne, *Telecommunications Industry*, The Technical Change Center (London: St. James Press, 1986); David Charles, Peter Monk, and Ed Sciberras, *Technology and Competition in the International Telecommunications Industry* (London: Pinter Publishers Limited 1989); Michael E. Porter, *The Competitive Advantage of Nations* (New York: The Free Press), 1990.

[3] The literature reviewed in this section generally categorizes communications equipment by product location, rather than by product function. CPE includes switching, transmission, and terminal communications products that are owned by the customer and located on his premises. Equipment owned by and installed in companies that furnish communications services to the public is not included in CPE, even though the product may be identical to that owned by the customer. Outside this review of literature, this study will rely on functional categories to differentiate the various types of equipment produced in the industry. In addition, the determinants of competitiveness associated with transmission equipment will not be discussed here because there is only limited discussion of these determinants in the literature.

[4] Export-Import Bank of the United States, *Report to the U.S. Congress on Tied Aid Credit Practices*, Washington, DC, April 1989; Ernest H. Preeg, *The Tied Aid Issue: U.S. Export Competitiveness in Developing Countries* (Washington, DC: The Center for Strategic and International Studies, 1989).

[5] See for example, Sciberras and Payne, *Telecommunications Industry*; Charles, Monk, and Sciberras,

has thus used a number of variables to quantify the concept of competitiveness. Two recent studies suggest that long-term profitability and market share are standard measures of competitiveness that may be applied to firms in the communications equipment industry.[6] The conclusions of a 1990 survey of top executives from 277 U.S. manufacturing companies considered relative profitability—that is, how well a business is doing compared with its immediate competitors—as a more appropriate measure of competitiveness than absolute profitability.[7]

What Makes a Firm Competitive Internationally?

Once competitiveness has been measured, it is possible to analyze factors that make a given firm more or less competitive internationally. One of the main determinants of competitiveness for the communications equipment industry suggested in the literature is the skill base of firms' manpower, particularly the core management. This determinant recognizes that the management of a firm must define and pursue long-term goals with respect to the following activities:

- product design and manufacturing;
- investment in advanced manufacturing equipment;
- economies of scale derived from the structure of the firm; and
- multiproduct manufacturing or economies of scope.

For the most part, the literature suggests, the determinants of competitiveness for communications equipment producers vary according to the level of technology of the equipment produced. For example, many CPE products typically involve relatively simple technology, whereas CO switching equipment is more sophisticated. The determinants of competitiveness for CPE suppliers will therefore differ from those applicable to producers of CO switching equipment. The determinants for each product sector are discussed below, followed by a review of the literature on official export financing programs that influence competitiveness in both product sectors.

The CPE Industry

Although the bulk of CPE is accounted for by terminal equipment, such as telephones and modems, the CPE industry also includes some switching equipment, such as PBXs. Terminal equipment is generally characterized by relatively simple technology, and is therefore well suited for mass production.[8] Hence, competitiveness in the terminal equipment segment of the industry depends on production and component cost advantages and quick response to shifts in consumer demand. For those products that cannot be mass produced, such as PBXs, competitive advantage is determined by the ability to customize equipment for specific users and to accommodate differing national standards.[9]

For the overall CPE industry, the literature identifies factors that are internal to the industry, such as manufacturing techniques, as more important than external factors, such as government policy, in determining international competitiveness.[10] A study by The Brookings Institution indicates, however, that external factors such as exchange rates can determine the international competitiveness of CPE producers. This study of the telecommunications industry notes that "from 1982 through 1987, the U.S. trade balance in telephone equipment shifted from a surplus to a deficit of $2.7 billion, undoubtedly spurred by the strong dollar ... as the dollar recedes and the initial surge in consumer purchases of CPE ebbs, the trade deficit in telephone equipment will probably begin to decline."[11]

Two studies discuss product standardization and advanced manufacturing techniques as methods that firms can use to enhance competitiveness. They indicate that firms can save money by producing standardized rather than differentiated products, because of economies of scale.[12] According to these studies, standardization in product design tends to reduce the number and variety of components, thus lowering costs and increasing product reliability. Second, one study points out that many producers of CPE equipment use advanced manufacturing techniques such as surface-mount technology, computer-aided design, and just-in-time inventory control to enhance competitiveness.[13] Both studies indicate that such techniques reduce manufacturing delays, increase manufacturing flexibility, improve product and process quality, and typically reduce costs. In particular, automation of the manufacturing process allows firms to save on labor costs. Further, these studies suggest that advanced manufacturing

---

[5]—*Continued*
Technology and Competition in the International Telecommunications Industry; Hayes and Abernathy, "Managing Our Way to Economic Decline," *Harvard Business Review*, July-August 1980; J.C. Panzer and R.D. Willig, "Economics of Scope," *American Economic Review*, 71(2) May 1981.

[6] Sciberras and Payne, p. 18; Charles, Monk, and Sciberras, p. 16.

[7] Ernst & Young, *American Competitiveness Study: Characteristics of Success*, E&Y No. 58059, 1990.

[8] Information Computer Communications Policy (ICCP), "The Telecommunications Industry: the Challenges of Structural Change," Organization for Economic Cooperation and Development (OECD), draft report, Paris, 1991.

[9] Sciberras and Payne, p. 27.

[10] Ibid., Hayes and Abernathy.

[11] Crandall, pp. 100 and 102.

[12] Sciberras and Payne, p. 21; Charles, Monk, and Sciberras, p. 113.

[13] Ibid, p. 128.

techniques also improve a firm's ability to shorten the cycle time of a product while improving quality.[14]

Another study considers vertical integration within firms to be an important factor for competitiveness. According to this study, vertically integrated firms are able to source critical components internally and thus, control component costs and respond quickly to market changes.[15] In addition, such firms have lead-time advantages because the proprietary nature of these critical components may prohibit new products from being easily imitated by competitors.

Several other factors were cited in the literature as instrumental to competitiveness in the CPE market. One of the most important was closer links between research and development (R&D), manufacturing, and sales activities, because coordination between these activities improves the rate of product commercialization. The literature also considered marketing strategy and management's ability to evaluate and efficiently allocate skills and training of the work force to be significant competitive factors.

In summary, the competitiveness of firms in the CPE segment of the communications equipment industry is determined, as suggested by Michael Porter, by the way firms manipulate the "value chain" relative to competitors.[16] Porter recommends dedication to relentless upgrading, improvement, and innovation at all levels of the value chain from R&D to after-sales services. He suggests that firms sell to demanding customers to feel the pressure to innovate, regard employees as permanent and enhance their skill levels accordingly, and help upgrade local suppliers to reap the rewards of cooperation.

The CO Switching Equipment Industry

There are three principal internal factors influencing the competitiveness of CO switch producers. First, successful equipment manufacturers possess leading-edge technology and use it both in designing and manufacturing switching equipment. Second, they have shorter product-development cycles and the ability to tailor equipment to customers' specifications. Third, in order to compete in the CO market, manufacturers ensure that new products are compatible with existing communications equipment in the network. Each of these factors is discussed in more detail below.

Unlike CPE equipment, the product and process technology associated with CO switching equipment is very sophisticated, requiring custom software for each switch. As a result, R&D costs associated with modern, digital CO switches are extremely high. A study by the Massachusetts Institute of Technology notes that the rising importance of software has transformed the CO switching equipment segment of the industry from a high variable-cost activity to a high fixed-cost activity.[17] Development of a new digital CO switch currently costs between $1 and $1.5 billion, with about 75 percent of the total spent on software development.[18]

According to two studies, large increases in R&D have resulted in increased minimum efficient scale[19] of switch production; consequently, companies must sell into larger markets to recover R&D costs.[20] In order to undertake these large development costs and establish a presence in foreign countries, joint ventures have become increasingly common in the CO switching equipment industry and have contributed to its globalization.[21] With respect to strategies for market entry, one study noted that firms tend to engage in licensing, joint ventures, original equipment manufacturing arrangements, or establish production capacity in foreign countries to gain market share.[22]

Competitiveness in the CO switch market also depends on gaining and keeping an early lead in the introduction of products with advanced capabilities. During the late 1970s, AT&T used analog rather than digital design for its CO Class 5 switch for service in local central offices, despite having developed digital technology and having used it in other parts of the network. At the time, AT&T did not believe it was necessary or economical to upgrade its CO equipment with new technology.[23] This strategy backfired when Northern Telecom introduced a CO Class 5 digital switch in 1979.[24] According to Hausman and Kohlberg, the Bell operating companies (BOCs), which had previously purchased switches almost exclusively from AT&T, chose increasingly to buy the Northern Telecom switch, in part because its advanced technical capabilities were far ahead of those found in AT&T CO switches. The BOCs also turned to Northern Telecom because the U.S. Government's antitrust suit against AT&T at that time created uncertainty about the future, leading the BOCs to seek alternate suppliers.[25] By 1984, when the AT&T divestiture took place, almost all new CO switches purchased were digital and Northern Telecom had captured a major share of the U.S. market.[26]

---

[14] Product cycle time refers to the time required to send a product completely through the manufacturing process, from purchased input to final product.

[15] Sciberras and Payne, p. 141.

[16] Porter, p. 41.

[17] Hausman, p. 5.

[18] Ibid.

[19] The minimum efficient scale of production refers to the quantity of output required for a manufacturer to realize all possible cost reductions. The auto industry is frequently cited as an industry with a large minimum efficient scale of production.

[20] Hausman and Kohlberg, p. 193; Hausman, p. 70.

[21] Hausman and Kohlberg, p. 197; Hausman, p. 2.

[22] Sciberras and Payne, p. 73.

[23] Hausman and Kohlberg, p. 197.

[24] Ibid.

[25] Ibid.

[26] Different authors have reported different percentages for how large a share Northern Telecom was able to capture in the U.S. market. For example, this percentage varies from 42 percent according to Crandall, 70 percent according to a Department of Commerce publication, and 85 percent according to Hausman and Kohlberg. Crandall, p. 81; Hausman and Kohlberg, p. 197; U.S. Department of Commerce, ITA p. 135.

Incompatible equipment standards can also influence the relative success of international competitors. According to Hausman and Kohlberg, European manufacturers, except Siemens, have been unsuccessful in entering the U.S. market because the features their switches offer are incompatible with North American standards.[27] ITT, a major supplier in the international CO switch market, withdrew from the U.S. market in 1986 because of software development problems which precluded it from adapting its switch to North American standards.

The primary external competitiveness factors are government policies and market size.[28] Government policy can influence competitiveness in many ways, including subsidizing R&D costs or requiring telephone network operators to buy equipment from domestic firms.[29] Both political and economic considerations may lead a national government to select a preferred supplier as a national champion.[30] In European countries, for example, communications service providers are typically government-owned monopolies with close supplier relationships to only a few domestic equipment manufacturers. Governments may also require that communications service providers buy equipment with specified domestic content in order to retain jobs, technology, and production within their borders.[31]

Incompatible national standards can be used to help or hinder a firm's competitiveness, when established to give an advantage to domestic producers. A U.S. Department of Commerce (DOC) report states that CO switch manufacturers rely heavily on government policy both in home and foreign markets:

> Government policies can help to preserve domestic market share for domestic manufacturers or promote international competition in the domestic market. Government policies can also assist domestic manufacturers in gaining access to foreign markets.[32]

The main external factor affecting the competitiveness of CO switch producers is the size of their domestic market which in most cases is relatively closed. Large, homogeneous markets, such as the United States, or, potentially, the EC and China, permit equipment suppliers to take advantage of economies of scale and provide an opportunity to recover product-development costs. A significant share of a large domestic market can give a company the stable base it needs to fund entry into foreign markets. However, developed countries, traditionally large markets for CO switching equipment, are expected to be among the slowest growing CO switch markets in the near future. According to OECD estimates, the growth rate in access lines in the early 1990s is expected to be less than 2 percent in North America and about 6 percent in Western Europe.[33] Therefore, the opportunity to increase sales in these countries is somewhat limited.

In contrast, the annual growth rate of access lines in developing countries is expected to range from about 16 percent in the Asian countries to about 59 percent in Eastern Europe.[34] Although the lack of hard currency may reduce this potential, any substantial growth in demand for advanced CO switch equipment, particularly digital switches, will thus likely come from developing countries that have yet to implement modern telecommunications systems. However, if the BOCs find it economical to replace existing switches, demand for digital CO switches would increase significantly in the United States.[35] This replacement demand depends on the tradeoff between avoiding large investments by maintaining low-cost basic service and growing demand for integrating voice and data communication services that require digital switches.[36]

Because developing countries represent such a potentially large source of demand for CO switching equipment as well as other communications equipment, the ability to successfully sell to these countries becomes an important determinant of competitiveness for the entire communications equipment industry. Use of official export financing programs is reportedly an increasing method of successfully marketing equipment to developing countries. The influence of this competitiveness factor is discussed in the following section.

How Export Financing Affects International Competitiveness

Official programs used to finance exports of communications equipment to developing countries often consist of tied aid and mixed credits. Tied aid credits include loans, at normal and concessionary terms, that are tied to procurement of goods and services from the donor country. Mixed credits combine concessionary government funds with commercial or near-commercial funds to produce lower-than-market-based interest rates and more lenient loan terms.[37] According to the Department of Commerce study cited above, many foreign governments provide attractive financing packages to support export sales of domestic manufacturers. For example, the Governments of France and Japan reportedly offer equipment financing at interest rates as low as 3.5 percent over a 30-year term with a 10-year

[27] Hausman and Kohlberg, p. 200.
[28] Ibid, p. 214.
[29] Hausman, p. 6.
[30] Ibid.
[31] Ibid.
[32] U.S. Department of Commerce, International Trade Administration, p. 139.
[33] ICCP, "Telecommunications Equipment: Changing Markets and Trade Structures," ICCP No. 24, draft report, March 1991, OECD, Paris, France.
[34] Ibid.
[35] Hausman and Kohlberg, p. 206.
[36] Ibid.
[37] Export-Import Bank, *Report to the U.S. Congress*, p. 227.

grace period. In contrast, a typical U.S. Export-Import Bank financing package offers interest rates at between 8 and 9 percent over a 10-year term with a 6-month grace period.[38]

Two recent studies conducted by the Export-Import Bank and the Center for Strategic and International Studies (CSIS) assess how official export financing affects the competitiveness of U.S exports of high-technology equipment associated with communications, power generation, and computer industries.[39] The Export-Import Bank study estimates that U.S. export sales of communications equipment lost due to lack of tied aid financing averaged between $85 and $260 million annually during 1985-88.[40] These estimates include a $100 million contract for digital switching equipment for Jordan and a $30 million sale for similar equipment to Jamaica. NEC won both contracts because of tied aid financing provided by the Japanese Government.[41] The communications equipment sales won by U.S. companies due to tied aid credits were generally much smaller, ranging from a $21 million domestic satellite network to an $8.5 million cellular radiotelephone system both destined for Gabon.[42]

According to the Export-Import Bank report, the United States may be losing $400 to $800 million annually in capital infrastructure projects, including communications, because of tied aid policies.[43] The CSIS report, however, considers these estimates to be very conservative, because of the methodology used in the Export-Import Bank study.[44] According to the CSIS report, the Export-Import Bank study was not comprehensive in its survey and did not extrapolate its findings to the entire scope of the industries studied. In addition, the CSIS report states that averaging 1985-88 data and limiting the types of tied aid surveyed presented a misleading picture of sales lost. After adjusting for these factors the CSIS report estimates that U.S. companies' total lost sales range between $2.4 and $4.8 billion annually.[45] These estimates do not reflect longer term losses of U.S. exporters due to lost opportunities for follow-on sales. The CSIS report does not estimate lost sales of communications equipment because complete and current information on official financing is not readily available.[46]

According to the CSIS report, donor countries use several techniques to provide tied aid credit financing. For example, the Japanese tend to link engineering and consultancy portions of capital project loans to Japanese engineering firms, while opening much of the actual equipment procurement to international competitive bidding.[47] Once Japanese firms develop detailed engineering specifications for a project, however, procurement of major capital equipment is awarded de facto to Japanese suppliers. Another technique is to provide engineering services for large projects on a grant basis while financing equipment procurement through loans. According to the CSIS study, U.S. engineering firms seldom benefit from tied aid credits or grants and have thus been steadily losing market share in Asia.[48]

The CSIS study recommends that the United States pursue an effective tied aid credit policy that would integrate export competitiveness, developmental assistance, and foreign policy objectives. The United States lacks such an integrated mechanism, according to the CSIS study, because the mandates of the executive branch and the jurisdictions of congressional committees separate these objectives. On the other hand, Japan and other aid donors follow a more integrated approach, with commercial interests often being predominant issues.

Industry Opinion

While academic and political discussions of the nature and determinants of competitiveness are important sources of information, the perspective of industry representatives is also critical to understanding sources of competitive advantage in the industry. This section presents the views that industry representatives expressed during in-person and telephone interviews in the United States, Europe, and Japan. The opinions focus on two major types of competitiveness factors: government policy, which is external to the firm, and company policies, which are internal to the firm.

Government Policy

Several companies with U.S. operations characterized U.S. Government policy as confused and undirected. An official at a Japanese plant operating in the United States observed that industry and Government seem to be at odds in the United States, whereas they work together in other countries. Government assistance to communications equipment producers in other nations takes several forms, as shown below. In general, both equipment producers and service providers indicated that domestic government policies have a profound effect on operations.

The following section provides a summary of industry representatives' views on regulation, R&D assistance, intellectual-property rights protection, standards, and trade policies. While some members of the industry mentioned differences in tax policies across nations, these distinctions pertained primarily to R&D supports, which are discussed separately below.

[38] U.S. Department of Commerce, ITA p. 139.
[39] Export-Import Bank, *Report to the U.S. Congress*; Preeg.
[40] Export-Import Bank, *Report to the U.S. Congress*, p. 142.
[41] Ibid, pp. 190-191.
[42] Ibid, p. 206.
[43] Ibid.
[44] Preeg, p. 6.
[45] Ibid.
[46] Ibid, p. 14.
[47] Ibid, p. 8.
[48] Ibid, p. 9.

Antitrust and the Bell Operating Companies

The most contentious issue concerning government regulatory policies was the 1982 Modification of the Final Judgement (MFJ) divesting AT&T of its Bell operating companies (BOCs).[49] A provision of the MFJ restricts the BOCs from manufacturing equipment for the U.S. market and limits their equipment-related R&D activities as well. Some industry and government officials believe this limit on BOC manufacturing actually enhances the global competitiveness of U.S. communications equipment firms by separating the supply of equipment from the communications service provider. This separation eliminates the potential for the service provider to subsidize inefficient equipment production with revenues earned in the monopolized communications services market.

Many members of the global communications equipment industry maintain that the MFJ actually reduced the competitiveness of U.S. communications equipment suppliers by restricting BOC manufacturing activity and precluding their involvement in research and development or joint ventures with equipment manufacturers. Several officials noted that the uncertain future of these legal restrictions hampers the BOCs' ability to establish long-term plans. Although technology continues to change, the BOCs are unable to send clear signals to manufacturers about the technological path they wish to pursue with future equipment. A Japanese manufacturer said that the MFJ is partially responsible, together with State and FCC regulations, for limiting technological development in the U.S. communications infrastructure. As a result, end users often turn to private networks, diluting the capabilities of the public network.

Foreign equipment manufacturers' involvement in the U.S. market is a key issue in this debate. By procuring communications equipment from overseas suppliers, the BOCs and other network operators transfer revenue, profits, manufacturing, and employment out of the United States. Members of the industry contend that MFJ manufacturing and R&D constraints on BOC activities in the United States have made foreign investments more attractive to the BOCs. The BOCs subsidize foreign firms' R&D and investment not only by buying their equipment, but also through joint ventures and other business combinations, thereby enhancing foreign producers' competitiveness.

Research and Development

Members of the industry indicated that R&D spending was highest in the switching segment of the industry, followed by transmission equipment and finally terminal equipment, which uses comparatively lower technology. Most of the officials contacted agreed that R&D demands were rising rapidly and that any government subsidies or other measures promoting R&D conveyed competitive advantages to equipment suppliers. At the same time, equipment suppliers connected to the communications service provider may benefit from funds received through cross-subsidization[50] from the service provider to support R&D efforts. This support allows equipment producers to export their products at artificially low prices in order to build market share, providing another form of competitive advantage.

Companies noted that government-sponsored cooperative R&D in the EC, such as the RACE[51] and ESPRIT[52] programs, provides direction to the EC industry. The Key Technology and Basic Manufacturing Centers in Japan were cited as offering similar advantages to Japanese firms. Several officials also pointed out that Japan's military budgets are limited by the nation's constitution, resulting in more government funds directed toward civilian R&D. In contrast, U.S. military R&D activities often displace commercial R&D projects, placing U.S. producers at a disadvantage when compared with Japanese rivals in the communications equipment industry. In addition, several U.S. industry representatives complained that the temporary nature of the U.S. R&D tax credit made planning and budgeting for R&D difficult and encouraged U.S. companies to adopt short time horizons.

Intellectual-Property Rights

A consensus existed among members of the industry that patents were becoming less important as a competitive tool. This trend is attributed partially to the rapid pace of technological advance and the increasing cooperation among members of the industry, which together imply that many firms are gaining and sharing knowledge simultaneously. On the other hand, industry representatives reported that copyrights covering software programs were becoming more valuable to equipment producers due to the rising importance of software in the industry. Potential violations of intellectual-property rights did not seem of particular concern to communications equipment manufacturers, although many noted that problems arise because patent and copyright processes are not comparable across countries. One European firm said that Japan's patent protection is insufficient because many patents may be filed for slight modifications of the same article.

An official of a Japanese-owned plant located in the United States believes the patent application and investigation process in the United States requires review. He stated that Japan publishes patent applications before they are granted to allow challenges

[49] See ch. 4 and 5 for more information.

[50] Cross subsidization refers to a firm's use of income or profits from one line of business to fund the manufacturing or development activities of another line of business.

[51] Research and Development in Advanced Communications Technology in Europe.

[52] European Strategic Program for Research and Development in Information Technology.

to the application outside the court system. This practice provides the examiner a better view of the state of technological development among various parties and strengthens the patent process, according to this official. In contrast, he claims that U.S. patent examiners are rated on the number of patents reviewed and thus tend to grant patents without rigorous investigation. Patents are thereby left open to subsequent challenge.

Standards

The opinion of the communications equipment industry is divided on how standards affect global competitiveness. Some regard standards as barriers to market entry that may be used to shelter domestic suppliers from foreign competition. Industry representatives expressed this view to varying degrees while describing the standards regimes in the EC, Japan, and the United States. Others felt that standards open markets to competition, by equalizing the purchase criteria for all market participants, which allows objective evaluation of price and performance and improves suppliers' competitiveness. Industry representatives generally agreed that developing common standards is critical to reduce confusion and costs.

Several industry representatives indicated that U.S. firms were at a competitive disadvantage in attempting to enter foreign markets and overcome barriers imposed by incompatible standards. This disadvantage stems from historical concentration on the vast, homogeneous U.S. market; only recently have most U.S. producers begun to develop products based on the myriad sets of foreign standards. At the same time, many industry representatives felt that all suppliers to the U.S. market were handicapped by the lack of a central standard-setting apparatus in the United States. One company characterized U.S. standard-setting organizations, which include Bellcore, the Electronic Industries Association, and the Telecommunications Industry Association, as more dispersed and haphazard than those of other nations.

Trade Policy

Import barriers were absent from most companies' lists of trade policy concerns. Instead, industry representatives indicated that export controls and export financing programs had the most profound impact on their business. A North American company considered U.S. export control policies far more prohibitive than the import barriers of other nations. This company pointed out that import barriers could almost always be overcome with joint ventures or with sufficient expenditures, but export control restrictions were often insurmountable.

A representative from a European company identified Coordinating Committee on Multilateral Export Controls (COCOM) restrictions as a significant barrier to trade in communications equipment, noting that restrictions appear to serve political ends rather than security concerns. This representative also warned that such restrictions were locking the U.S. industry out of the Soviet market for fiber optics. Another European company spokesman said that COCOM is not always fairly enforced; occasions exist when the same contract is disallowed for one company and then approved for another. Japanese firms indicated that Japanese exports of sensitive technology were subject to stringent COCOM controls but that the Japanese Government was fairly efficient in processing the paper work necessary for these exports.

Other restrictive export policies include foreign policy controls and the U.S. Foreign Corrupt Practices Act. One industry representative claimed that foreign policy controls, such as restrictions on trade with Cuba, China, Vietnam and South Africa, create a tremendous disadvantage for U.S. equipment producers. U.S. companies are often not even invited to bid on contracts in these countries due to the provisions of the act.

As noted in the Review of Literature above, representatives of U.S. companies stated that the absence of U.S. Government-assisted financing was a significant competitive disadvantage. One representative stated that the U.S. Government should not support one manufacturer over another but pointed to the advantages created by government support to European equipment manufacturers, such as Alcatel in France and Siemens in Germany. Japanese firms interviewed by Commission staff indicated that they receive very little benefit from government-supported tied aid when marketing overseas, estimating that tied aid represented less than 10 percent of Japanese Government foreign aid. Several of the companies indicated, however, that tied aid and other low-cost financing were important elements in securing contracts in third-world markets, because developing countries often require that long-term, low-cost financing be included in equipment manufacturers' bids.

Company Policies

Industry representatives consistently expressed the belief that measuring competitiveness has become more complicated as products and companies become multinational. Competitiveness in high-technology products was considered particularly complex, because developing, manufacturing, and marketing these products often requires more than the resources of any one company and may involve cooperative efforts across several countries. Market-penetration efforts, advanced technological capabilities, and firm structure were cited as the major competitive factors under a firm's control.

Market Penetration Efforts

Most companies asserted that to sell communications equipment, particularly sophisticated network equipment, in foreign markets, they must establish a long-term presence in each market. Most

industry representatives agreed that persistence and commitment were essential to successful market entry but differed on the time required to gain acceptance in the market. A North American company said that a minimum of 3 years' presence, prior to initial sales, was required to enter a market, while Japanese firms indicated that they were prepared to wait 10 years to begin recouping their investment in foreign marketing operations.

Many companies commented on the problem of short investment time horizons of U.S. companies and, to a lesser extent, of European companies. Cited causes of this problem include the quarterly demands of stockholders, an overabundance of managers trained in finance rather than engineering, and differences in company structure. In general, members of the industry said that firms with long planning horizons and little pressure from stockholders for immediate profits would be more competitive in the long run because these firms would be able to invest more in research and development and would enjoy more flexibility in marketing strategies.

Persistence and commitment to markets, coupled with a reputation for employing advanced technology and good customer service, help equipment suppliers develop a base of customers in a particular market. Over time, this embedded base of equipment in existing networks is seen as the major barrier to new market entrants—but one that could be surmounted. One market-entry method mentioned frequently was to supply equipment to niche markets before attempting to enter mainstream markets. However, industry representatives pointed out that service providers are increasingly reluctant to have more than two or three suppliers of the same type of equipment, because multiple suppliers may lead to incompatible equipment, maintenance inefficiencies, or confusion among end users.

Communications equipment producers in Japan and Europe reportedly have an advantage over most of their U.S. counterparts because they have been more active in foreign markets, especially those subject to government procurement. This advantage may be pronounced when comparing the marketing efforts of a firm like Siemens, which produces and distributes a broad line of electrical and electronic equipment worldwide, with those of U.S. firms that are just beginning to enter international markets. In addition, former colonial ties were cited as conveying competitive advantages, particularly to European suppliers.

Japanese and European producers often use different, allegedly more successful market entry methods than their U.S. counterparts. Industry officials indicated that Japanese suppliers of communications equipment often realized competitive advantages from sharing technology with domestic producers in developing markets. U.S. firms are reluctant to transfer technology to emerging producers in developing countries, according to several members of the industry. Industry sources also claimed that Japanese and European firms were more willing than U.S. companies to take long-term minority equity positions in foreign firms to gain market entry.

Advanced Technology

Many companies described technological sophistication and compatibility with existing equipment as critical selling points, often more important than price in making sales. While industry representatives tended to agree that achieving a reputation for utilizing advanced technology is crucial for attracting new business, many noted that growth depends more on gaining additional markets than on delivering new, enhanced generations of equipment. A North American supplier mentioned that the U.S. market offers well-proven equipment to countries interested in upgrades. He said that most customers were not looking for radically new technology, just technology that was new to them. He reported that most customers were looking for products with a history of reliability and the reassurance that other customers were satisfied with the equipment.

A user of communications equipment confirmed that fast turnover of technology is not necessarily an advantage, because it makes long-term planning for the network difficult. The pace of technological change has led to concerns that any replacement for a user's current phone system will be outdated almost immediately. Fear of obsolescence makes winning approval for large capital expenditures difficult.

Industry officials indicated that developing leading edge software and employing sophisticated manufacturing techniques were the two most important areas for applying advanced technology in producing communications equipment. In terms of international comparisons, these sources mentioned that U.S. firms maintained a lead in the software arena, but Japanese manufacturers generally surpassed U.S. companies in manufacturing efficiencies. Industry sources also noted that Japanese firms were rapidly catching up with U.S. firms in the development of advanced, applications-oriented software. The gap between U.S. and Japanese software development is narrowing in part because Japanese firms have invested in software development facilities in countries noted for leading edge software development, such as the United States and the United Kingdom.

Firm Structure

Communications equipment manufacturing firms take many forms—from small enterprises that design or produce a narrow range of equipment or components to large, vertically integrated conglomerates that produce and sell into many different markets. Officials of small firms indicated that specialization in particular products or technologies allows them to respond more rapidly to changes in technology or in the market. Meanwhile, most large, vertically integrated producers seemed to regard their broad firm structure as

advantageous because it allows more control over the supply of critical components and permits them to better weather temporary downturns in individual markets. Most foreign-based firms felt that communications equipment producers that remain integrated with the provider of telecommunications services may enjoy the advantage of having revenues from the service market subsidize equipment production costs.

Some large, diversified companies stressed the advantage of possessing expertise in electronic and computer technology. Japanese manufacturers see the diversification of their firms into computers, electronic components, and communications equipment as a major competitive advantage that will provide important technological synergies in information technology. However, producers that concentrated in communications equipment, rather than components or electronic products, did not think their lack of integration was a disadvantage as long as they retained control over the manufacturing of certain critical components.

Economic Analysis of the Competitiveness of Communications Equipment Suppliers

Taking the views of academic researchers, industry analysts, and representatives of equipment and service suppliers into consideration, the Commission selected measures of competitiveness and identified determinants of competitiveness for the communications equipment industry. Figure 3-1 presents the Commission's analytical framework for examining U.S. competitiveness in the global communications equipment industry.

For purposes of this analysis, competitiveness will be measured by the export performance of the United States relative to its competitors, the other MEP nations.[53] Relative export performance is a more applicable measure of competitiveness than market share or long-term profitability because factors external to the firms frequently determine the extent to which a foreign supplier of communications equipment can sell in a given MEP or NEP country.

In the case of MEP markets, for example, the procurement policies of the communications service providers in most of these countries tend to favor domestic suppliers, leading to relatively closed markets. In the case of more open NEP markets, export financing and export-control policies of MEP countries tend to substantially affect the competitiveness of MEP-country suppliers.[54]

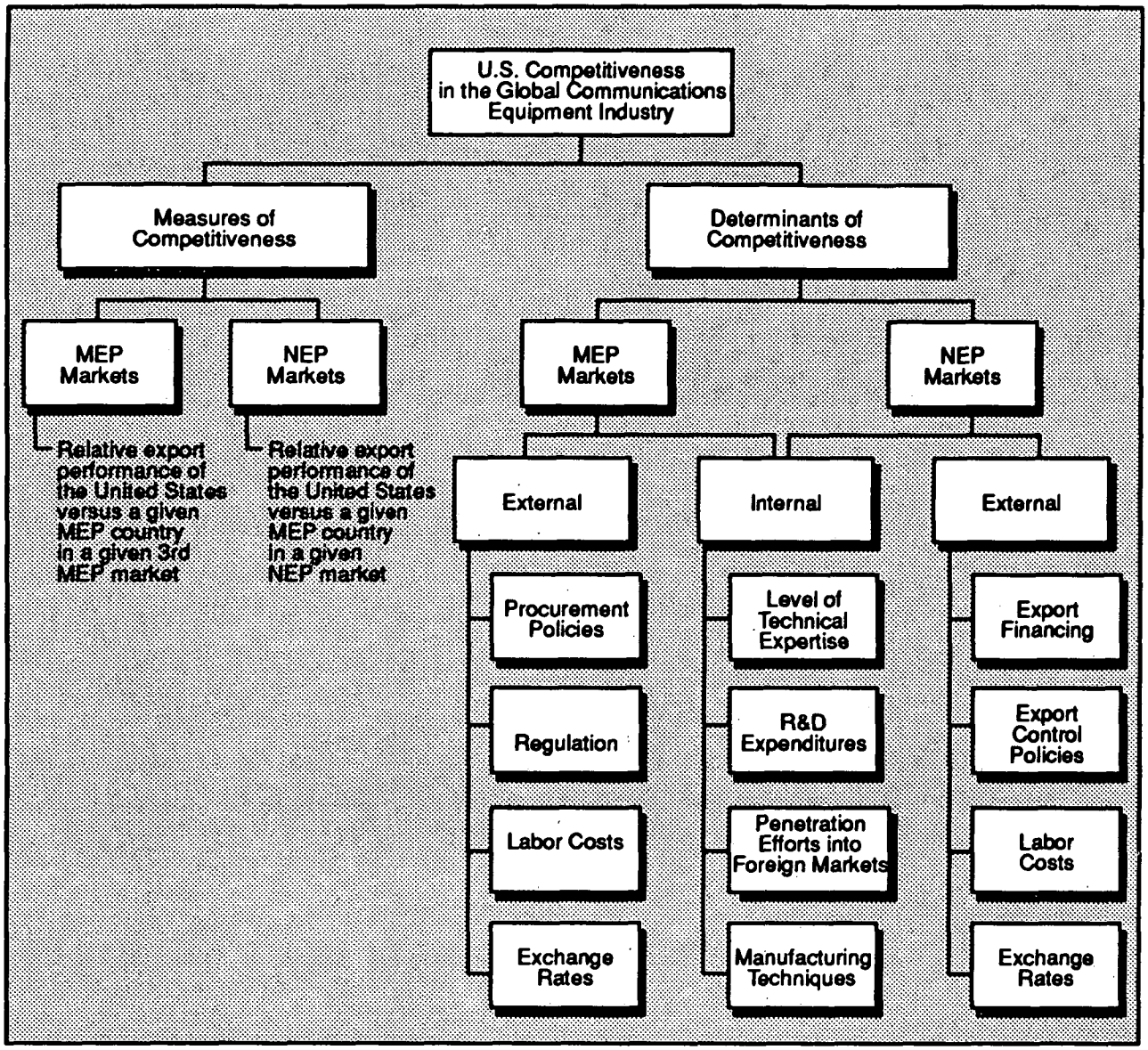
As shown in figure 3-1, internal determinants for MEP and NEP markets do not differ because it is expected that decisions faced by an equipment producer with respect to needs for technical expertise, R&D expenditures, efforts in penetrating foreign markets, or selection of manufacturing techniques are under the control of management, regardless of output destination. The primary differences between MEP and NEP nations lie in factors outside the control of an equipment producer's management decisions. For example, in MEP markets, regulation and the existing embedded base of equipment will influence how open these markets are to foreign competition. In the case of a NEP market, official export financing and export control policies can significantly affect equipment producers' ability to sell in a given NEP market in direct competition with other equipment producers. The internal and external determinants of competitiveness are discussed in chapters 4 and 5; a quantitative assessment of their significance in determining the export performance of the United States relative to other major equipment producers is presented in chapter 6.

---

[53] In this study, U.S. competitiveness is measured by comparing U.S. exports of communications equipment with those of its principal competitors in a given market. The measure will be referred to as relative export performance.

[54] See chapter 4 for detailed discussion of the government-related factors that influence equipment producers' competitiveness.

Figure 3-1
Analytical framework for U.S. competitiveness in the global communications equipment industry



Source: Staff of the U.S. International Trade Commission.

CHAPTER 4
GOVERNMENT POLICY

Introduction

Industrial competitiveness is determined not only by the actions of players within the industry but also by external forces. The most significant of these external forces is often government policies, including laws and regulations, in markets where major industry players operate. Variation in government policies across nations may create important distinctions in the endowments of nationally based companies as they enter the international market. Significant advantages may enable national champions to maintain a protected domestic position or gain a dominant international position.

Government policies are particularly influential in the communications equipment industry because of the close connection between the government and the communications sector. In many nations, a government or quasi-government agency provides communications services on a monopoly basis. Even in the United States, where communications services have always been provided by the private sector, the Government has maintained a close watch on the industry by regulating the provision of most communications services. Also, as a high-technology industry, communications equipment receives additional attention from governments because of national security concerns, government support for science and technology, and the strategic industrial policy of some countries.

The extent and type of attention national governments pay to the communications equipment industry, or to industry in general, varies considerably across countries. To some degree, these variations reflect historical circumstance and cultural differences. For example, the United States and the United Kingdom currently share a resistance to government involvement in private concerns, including industry. In contrast, Japan and France have a long history of government policies that establish plans or targets for certain industries.[1] The policies of European nations and Japan have also been influenced by the need to rebuild their economies after World War II.[2]

Differing perspectives and political approaches clash when national industries, which have been supported or restricted by their domestic governments, enter international markets. They also collide when foreign competitors seek to enter markets characterized by protective or discriminatory policies. In this way, government policy can influence competitiveness. This chapter focuses on a comparative analysis of policy areas relevant to competitiveness and briefly assesses their effect. Detailed descriptions of specific policy provisions are beyond the scope of this study. The most significant policies affecting competitiveness in the communications equipment industry include antitrust, regulation, research and development, and trade. Intellectual-property rights and research and development tax credits were also cited as government policies that can affect competitiveness.

Antitrust Policy

Antitrust laws are designed to encourage and protect competition in a free market economy. Modern antitrust laws first appeared in Canada and the United States in the late nineteenth century. By the mid-1900s, most industrialized nations had enacted antitrust or competition laws.[3] A catalog of antitrust laws and policies of most of the MEP countries is shown in figure 4-1 at the end of this section. Although antitrust laws of industrialized nations are similar in many respects, variations in enforcement and industry structures have tended to limit their effectiveness in certain countries.

Throughout much of the industry's history, communications services have been provided by a monopoly. In most countries, with the United States and Canada the principal exceptions, communications equipment has been supplied to the principal service provider by unaffiliated, private companies. The U.S. and Canadian industries differ from that in most other countries in two respects. First, the service provider is not and has never been a part of the government, and second, the principal service provider and equipment manufacturer were parts of the same company.

Because of these differences and because of varying views on enforcement of antitrust or competition laws, the United States, more than any other country, has sought to introduce competition into the services and equipment sectors through application of antitrust statutes. Therefore, an examination of how antitrust laws vary among nations is important to understanding the transformation of the communications industry.

U.S. Antitrust Laws

U.S. antitrust policy prohibits mergers that would result in firms being able to exercise significant

[1] For a description of these policies, see, for example, U.S. International Trade Commission, *Foreign Industrial Targeting and Its Effects on U.S. Industries, Phase I: Japan* (investigation No. 332-162), USITC publication 1437, October 1983; *Phase II: The European Community and Member States* (investigation No. 332-162), USITC publication 1517, April 1984; *Phase III: Brazil, Canada, the Republic of Korea, Mexico, and Taiwan* (investigation No. 332-162), USITC publication 1632, January 1985.

[2] Richard R. Nelson, *High Technology Policies: A Five-Nation Comparison* (Washington: American Enterprise Institute for Public Policy Research, 1984).

[3] Although the most frequently used term in the United States is "antitrust laws," many other countries refer to them as "competition laws." F.M. Scherer and David Ross, *Industrial Market Structure and Economic Performance* (Boston: Houghton Mifflin Company, 1990), pp. 12-13.

Figure 4-1
Selected Antitrust Laws and Policies in Certain Major Equipment-Producing Countries

COUNTRY/ REGION	YEAR	ANTITRUST LAW/POLICY	COVERAGE
UNITED STATES	1890	Sherman Act	• Forbids monopolization and restraint of trade
	1914	Clayton Act	• Forbids collusion or price discrimination
	1914	Federal Trade Commission Act	• Creates the Federal Trade Commission as a quasi-judicial and administrative agency to enforce the antitrust laws
	1918	Webb-Pomerene Act	• Provides limited antitrust exemption for the formation and operation of associations of otherwise competing businesses to engage in collective export sale
	1982	Export Trading Act	• Designed to increase exports of goods and services by reducing uncertainty concerning application of the U.S. antitrust law to export trade
	1984	National Cooperative Research Act	• Defines more clearly the application of U.S antitrust laws as they apply to joint research and development
CANADA	1910	Combines Investigation Act (CIA)	• Basis for Canadian antitrust laws
	1976	Amendments to CIA	• Extends antitrust enforcement to the services sector, bolsters the prohibitions against bid rigging and collusive agreements, and makes it easier for private litigants to file civil suits for antitrust violations
	1986	Competitions Act	• Replaces the Combines Investigation Act • Changes the criminal treatment of monopoly to civil treatment and applied criminal treatment only for flagrant attempts to monopolize which include bid rigging, predatory pricing, and price discrimination
EUROPEAN COMMUNITY	1957	Treaty of Rome -Article 85(1)	• Prohibits agreements and concerted practices between two or more enterprises that restrain competition
	1957	Treaty of Rome -Article 86	• Prohibits individual companies holding a dominant position in a relevant market to abuse that dominant position
	1965	Regulation 19 of 1965	• Gives the commission the power to grant antitrust exemption in the form of regulation on a block or group basis, without case-by-case review, as long as certain criteria are met
UNITED KINGDOM	1948	Monopolies and Restrictive Practices Inquiry and Control Act	• Gives the government power to conduct regulatory oversight of monopoly situations
	1956	Restrictive Trade	• Strengthens the Government's power by preventing collective agreements which restrain competition and harm the public interest
	1964	Mergers and Monopolies Act	• Authorizes investigation of mergers between firms considered large, based on their market share and asset value
	1973	Fair Trading Act	• Lowers from 33 percent to 25 percent the market share standards for defining monopoly situations

Figure 4-1—Continued
Selected Antitrust Laws and Policies in Certain Major Equipment-Producing Countries

COUNTRY/ REGION	YEAR	ANTITRUST LAW/POLICY	COVERAGE
FRANCE	Post WWII	Price Regulation System	• Covers monopolization and restraints of competition, including price fixing, tying practices, loss leader sales, resale price maintenance, and collusive tendering
	1977	Commission de la Concurrence	• Established to investigate antitrust violations and to suggest remedial measures
	1986	Ordinance	• Confines government price setting to those areas where price competition is believed to be ineffective • Strengthens French antitrust law by giving interpretation and enforcement of the law to the judiciary
GERMANY	1957	Acts Against Restraints on Competition (ARC)	• Forms the basis for German antitrust law • Forbids agreements which restrain production, competition, or market conditions with respect to commercial services or trade in goods
	1965	Amendment to ARC	• Allows the formation of cartels for certain concerted activities that promote economic and technical efficiency, the attainment of economies of scale by small- and medium sized firms, the promotion of exports, the writing of product standards, and the rationalization of depressed industries
JAPAN	1947	Law Relating to Prohibition of Private Monopoly and Methods for Preserving Fair Trade (The Antimonopoly Law)	• Seeks to ensure that revival of the concentrated economic power of the prewar "zaibatsu" do not take place • Based on the provisions of the U.S. antitrust statues such as Sherman, Clayton, and Federal Trade Commission Acts
	1949	Amendment to Antimonopoly Law	• Removes the ban on intercorporate stock ownership • Eases the restriction on mergers and acquisitions • Relaxes the restriction on shared directorates
	1953	Amendment to Antimonpoly Law	• Provides exemptions from the prohibitions placed on cartels • Legalizes many concerted activities
	1957	Small and Medium Enterprises Act	• Exempts small businesses from antitrust prohibitions with regard to concerted activities
	1977	Amendment to Antimonopoly Law	• Permits antitrust authorities to levy financial surcharges on illegal cartels • Institutes divestiture as a remedy for monopolistic situations • Permits antitrust authorities to require financial reporting in cases of parallel pricing by horizonal competitors • Restricts financial and non-financial corporations from certain stock holdings

Source: Compiled by the staff of the U.S. International Trade Commission.

"market power"[4] and also prohibits collusive activities in restraint of trade among competing firms. The laws setting forth these prohibitions are found in the Sherman Antitrust Act of 1890, the Clayton Act of 1914, and the Federal Trade Commission Act of 1914. The two Federal Government entities with primary responsibility for enforcing antitrust laws are the Federal Trade Commission and the Antitrust Division of the U.S. Department of Justice. Competitors, consumers, or suppliers of companies alleged to be engaging in anticompetitive conduct can also file private antitrust suits.

As competitive pressure on U.S. firms increased during the 1980s, the United States began to offer limited exemptions to and clarifications of antitrust laws to help U.S. industry compete more effectively in world markets. The Export Trading Company Act of 1982 was designed to increase U.S. exports of goods and services by reducing uncertainty concerning application of the U.S. antitrust laws to U.S. export trade.[5] Similarly, the National Cooperative Research Act (NCRA) of 1984 responded to concerns that U.S. antitrust rules governing joint ventures were discouraging precompetitive[6] joint research by U.S. firms. NCRA defined more clearly the application of U.S. antitrust laws to joint research and development (R&D) activities among U.S. firms in order to encourage firms to participate in cooperative research that does not have the type of anticompetitive effects that would violate antitrust laws. This and other proposed legislation was deemed necessary by Congress because it was feared that some members of the business community may be reluctant to enter into collaborative efforts because they erroneously perceive that the antitrust laws generally discourage all collaborative activity, irrespective of its effects on competition.[7]

Antitrust Laws in Other Equipment-producing Nations

The enforcement of competition policy in the other equipment-producing nations is considered to be less rigorous than in the United States. Indeed, these nations' governments have, in some cases, permitted the development of monopolistic enterprises to strengthen an industry's ability to compete in foreign markets. However, these countries are reevaluating their competition policies and appear to be moving toward stricter enforcement.

The European Community

EC antitrust rules prohibit business from obstructing free competition within the EC or trade between EC member states. Specifically, article 85(1) of the Treaty of Rome prohibits agreements and concerted practices between two or more enterprises, and article 86 prohibits individual companies holding a dominant position in a relevant market from conduct that constitutes an abuse of that position. Important block exemptions exist for research and development joint ventures and specialization agreements. Regulation 19 of 1965 gives the EC Commission the power to grant antitrust exemption in the form of regulation on a block or group basis, without case-by-case review, so long as certain criteria, such as firm size and market share, are met.

Japan

In Japan, the principal antitrust statute is the Law Relating to Prohibition of Private Monopoly and Methods for Preserving Fair Trade of 1947, commonly called the Antimonopoly Law. The law, enacted under pressure from U.S. occupation authorities after the Second World War, sought to ensure that the concentrated economic power of the prewar "zaibatsu" was not revived. The law is based largely on provisions of U.S. antitrust statutes, such as the Sherman, Clayton, and Federal Trade Commission Acts. The act is enforced by the Japan Fair Trade Commission (JFTC), an independent administrative and quasi-judicial body, responsible directly to the Prime Minister.

In comparison with U.S. antitrust enforcement, the general nature of the Japanese legal system has made its enforcement of antitrust laws more flexible. The Japanese legal system has traditionally discouraged litigation to pursue individual rights, including business rights, because such litigation is seen as disruptive to social harmony.[8] This tradition has made the role of antitrust law in the Japanese economy less significant than in the United States, where consumers and competitors are allowed to initiate private antitrust suits.

Shortly after the enactment of the Antimonopoly Law, Japan began to revise its antitrust laws to allow competitors to work together and to exempt specific industries from its provisions.[9] Various modifications

[4] "Market power" is defined as the ability of one or more firms to maintain prices above competitive levels for a significant period of time. *See* U.S. Department of Justice, Antitrust Division, *Merger Guidelines*, U.S. Department of Justice, June 14, 1984.

[5] 15 U.S.C. Sections 4001-4053 (1982).

[6] Precompetitive research is a stage of research between basic, nonproduct-oriented research and commercial, applications-oriented research.

[7] On June 12, 1990, the House Judiciary Committee reported favorably on a bill to amend the NCRA to reduce the risk of antitrust liability for joint ventures entered into for the purpose of joint production. The report stated that "Correctly understood, the antitrust laws prohibit only anticompetitive production joint ventures," and noted that production joint ventures had rarely, if ever, been challenged under the antitrust laws. It stated that the legislation was nevertheless desirable because some members of the business community erroneously perceive that the antitrust laws generally discourage all collaborative activity, irrespective of its procompetitive benefits.

[8] USITC, *Phase I: Japan's Distribution System and Options for Improving U.S. Access* (investigation No. 332-283), USITC publication 2291, June 1990, p. 10.

[9] Changes in the law removed the ban on intercorporate stock ownership, eased the restriction on mergers and acquisitions, and relaxed the restriction on shared directorates. Legal cartels were authorized by special

and exemptions, many promulgated by MITI as part of its overall industrial development policy, continued through the 1960s. However, in the 1970s, Japan took several steps toward stricter enforcement of antitrust laws. Japan enacted amendments to antitrust laws, including imposition of surcharges on undue profits arising out of illegal price-fixing arrangements, increased fines, and reporting requirements in the case of parallel price increases by leading enterprises in concentrated industries. The JFTC was also authorized to order corporate dissolution or divestiture if concentration in an industry was accompanied by barriers to entry, lack of price decreases, and unusually high profits. Despite these steps, Japan continued to rely on antitrust exemptions for both declining and leading edge industries and its antitrust enforcement was widely perceived as ineffectual. U.S. concern about the implications of antitrust statutes for U.S. market access in Japan led U.S. negotiators to push for major changes during the recent Structural Impediments Initiative (SII) negotiations.[10]

Effect on the Industry

Overall, antitrust policy has played varying roles in the MEP nations. Application of antitrust laws transformed the communications equipment market structure from monopolistic to competitive in the United States. In contrast, other MEP nations' antitrust policies had little or no effect on increasing the level of competition in the communications service or equipment industries. Instead, these countries have largely allowed the communications industry to function in a monopolistic market. Only recently has there been any increase in the level of enforcement of antitrust laws by Japanese and EC authorities, and it is too early to tell if this trend will produce lasting effects.

The United States and AT&T

Since the beginnings of the U.S. communications industry, antitrust concerns regarding AT&T have existed. In the early years, the U.S. Government considered the communications industry a natural monopoly[11] and did not interfere with AT&T's role as the near-monopoly supplier of telephone services and as the dominant supplier of telephone equipment. However, by 1912, AT&T's refusal to interconnect its Bell facilities with the systems of independent operating companies nearly resulted in an antitrust suit. In that year, the independent operating companies requested that the Department of Justice initiate an investigation to determine whether AT&T was violating the Sherman Antitrust Act by monopolizing communications services and equipment.

In order to prevent an antitrust suit, AT&T entered into the 1913 Kingsbury Commitment. Under the terms of the agreement, AT&T promised to allow other telephone networks to connect with its network, to stop purchasing competing telephone companies without the consent of the Interstate Commerce Commission, and to divest itself of its interest in Western Union. In return, the U.S. Government abandoned efforts to dismantle AT&T's network. This agreement represented the first step in Federal regulation of telephone service activities and, in exchange, allowed AT&T continued monopoly power over telephone service and the communications equipment market in the United States.

Even though AT&T surrendered some of its autonomy to the Federal Government in the Kingsbury Commitment, a continuing concern about its ability to cross-subsidize its equipment manufacturing operations with revenues from its service monopoly continued to provoke charges of anticompetitive behavior. After World War II, Government sentiment increasingly shifted against AT&T's monopolistic position. The Department of Justice's concern centered on the vertical integration of telephone services with equipment production, since AT&T purchased nearly all of its equipment from its captive supplier, Western Electric, essentially monopolizing the communications equipment market.

In 1949, the Department of Justice filed suit against AT&T, requesting that the company divest itself of Western Electric and that the Bell System make its equipment purchases through a competitive bidding process.[12] The 1956 Consent Decree settled the case by prohibiting AT&T from manufacturing any products not used to provide common-carrier communications services.[13] The decree also forced AT&T and Western Electric to grant licenses for all past and future patents, opening the door for new entrants to commercialize AT&T's technology, while at the same time precluding AT&T from entering other markets.

---

[9]—*Continued*
exemptions or as depression or rationalization cartels and numerous industries undertook production curtailments in the 1950s, pursuant to administrative guidance issued primarily by MITI. During the 1960s, MITI policy encouraged mergers in an effort to build up enterprises large enough to compete with the leading enterprises in the United States and Europe. The approval authority of the JFTC over mergers was also changed to a prior notification requirement.

[10] For background see *Phase II: The European Community and Member States*, October 1990 and USITC, *Operation of the Trade Agreements Program 42st Report, 1989*, USITC publication 2317, September, 1990, and *Operation of the Trade Agreements Program 42nd Report, 1990*, USITC publication 2403, July, 1991.

[11] That is, it was considered to be an industry in which one company could supply service more cheaply than two or more companies.

[12] United States v. Western Electric Co., Inc. and American Telephone and Telegraph Company, Civil Action 17-49 (D.N.J. 1949).

[13] Robert W. Crandall, *After the Breakup: U.S. Telecommunciations in a More Competitive Era*, (Washington, DC: The Brookings Institution, 1991), p. 19.

In the 1970s, as technological advances continued to change the nature of communications services, the Department of Justice reevaluated its earlier position set forth in the 1956 decree. Evidence increasingly supported the idea that, because of new technologies, other companies could efficiently provide services in competition with AT&T. In October 1974, the Department of Justice filed suit[14] against AT&T, charging that it had violated the Sherman Act by monopolizing the market not only for communications equipment, but also for interstate communications services and sought to separate both Western Electric and Bell Laboratories from AT&T.[15]

In 1982, the suit was resolved by a compromise that modified the 1956 consent decree, known as the Modification of the Final Judgment (MFJ). The terms of the MFJ required that AT&T divest its local Bell operating companies (BOCs), which were subsequently organized into seven regional holding companies (RHCs) on January 1, 1984. The MFJ removed the earlier decree restrictions that limited AT&T's manufacturing to communications equipment and authorized it to enter freely any market it chose. The MFJ also placed certain line-of-business restrictions on the activities of the BOCs that forbid the BOCs from entering competitive markets such as manufacturing communications equipment or providing long distance and information services.[16]

The MFJ's transformation of AT&T substantially altered the communications equipment industry both in the United States and in other countries. Prior to the MFJ, Western Electric was the principal supplier of communications equipment to the Bell system, which represented approximately 80 percent of the total U.S. market. The MFJ's establishment of the BOCs as entities separate from AT&T created a huge market with greater incentive for cost efficiency, since it was no longer affiliated with an equipment manufacturer. This large, independent, homogeneous market quickly attracted other suppliers, both domestic and foreign, to either enter or expand their share of the communications equipment market. Thus, the equipment-producing sector experienced a transformation which left it with more suppliers and greatly expanded opportunities. The change also affected AT&T, the largest manufacturer of communications network equipment in the United States. By lifting the restrictions on the equipment markets in which it could compete, the company was free to diversify into any competitive market it chose.

[14] United States v. American Telephone and Telegraph Co., Civil Action 74-1698 (D.D.C. November 20, 1974)

[15] Crandall, p. 36.

[16] In United States v. Western Electric, 675 F. Supp. 655 (D.D.C. 1987), the U.S. District Court for the District of Columbia held that the manufacturing restriction prohibited the RHC's design and development of telecommunications equipment and customer premises equipment as well as the fabrication of such equipment. On July 25, 1991, a U.S. District Court order lifted the information services restrictions on the BOCs.

Other Equipment-Producing Nations

With the exception of the United States and Canada, communications service providers in most countries are government owned or controlled, independent of equipment suppliers, and still regarded as natural monopolies. Antitrust laws have not been used to open these markets to competition in the way they have in the United States. However, Japanese antitrust authorities, under considerable U.S. pressure, have enforced at least one aspect of antitrust laws pertinent to the communications equipment industry. In May 1991, the Japanese Government announced that it would fine 3 of 12 companies charged with rigging bids for communications equipment. The group of companies, known as Kabuto Kai, had formed an illegal cartel to rig prices on contracts to U.S. military bases for over 100 million dollars' worth of telecommunications equipment. According to Japanese and U.S. government sources Kabuto Kai was found to have rigged bids to earn excessive profits on 27 contracts. As a result, a subsidiary of NEC Corp. has tentatively agreed to pay $34 million in restitution to the U.S. Government and was fined $1.7 million by the Japanese Government.[17]

The European Community has begun to apply new regulations to mergers taking place in the European communications industry.[18] On April 12, 1991, the EC Commission concluded its first inquiry under its 6-month-old EC merger regulation. The inquiry focused on merger negotiations between French and Italian producers of communications equipment. The EC approved a merger between Alcatel and Telettra on condition that Telefonica, the Spanish telephone service monopoly, divest itself of its holdings in Alcatel and Telettra subsidiaries in Spain, which together supply 80 percent of the transmission equipment in Spain. The concern driving the EC Commission is that Telefonica's continued investment in an equipment producer would discourage competition in the Spanish market. As an adjunct to the case, Telefonica has assured the EC Commission that it will stop giving preference to Spanish-based manufacturers when awarding contracts and select a third equipment supplier.[19]

Regulatory Policy

In most nations governments regulate communications service providers, but not the communications equipment manufacturers. Until recently, communications services in most countries were provided by a monopoly—either a government or quasi-government agency or a private enterprise. Governments have traditionally overseen the

[17] Paul Blustein, "Trustbusters Take On the Dango," *Washington Post*, May 14, 1991.

[18] Council Regulation No. 4064 on the Control of Concentrations Between Undertakings, Official Journal of the European Community, No. L 395 (Dec. 30, 1989), p. 1 (referred to as "merger regulations").

[19] Andrew Hill, "Brussels Imposes Strict Conditions on Merger," *Financial Times*, April 13, 1991.

communications service monopoly to insure that it operated in a manner consistent with national goals. Such goals include providing universal service, maintaining national security, developing leading-edge technologies, and raising revenue for the nation's treasury.

As technological advances change the nature of networks, the advantages of having a single service provider decline. Thus, some countries are diluting the monopoly power of communications service providers by deregulating or liberalizing certain portions of the industry. Indeed, absolute monopoly provision of telecommunications services is declining throughout the world.[20] Business and some residential users of the network generally welcome steps toward deregulation because they expect market forces will force service providers to offer a greater variety of services and equipment, often at a lower price.

Regulatory policy in the communications sector is clearly in a state of flux in many countries. What was once a state-controlled or monopoly market is being reevaluated and transformed into a competitive one. The United States, the United Kingdom, and Japan were early leaders in this transformation, but other nations that view communications infrastructure as the key to economic growth are likely to follow this lead. Overall, "democracy in telecommunications" has soared, in that service users, particularly large international users, now demand higher quality, and faster, more varied, lower cost communications services.[21] Figure 4-2 at the end of this section outlines selected regulations affecting communications in MEP countries.

Current deregulation of the communications service sector is also resulting in shifts in supply of communications equipment. Deregulation of the service provider is often combined with a liberalization of the market for equipment including regulations concerning attachment of equipment to the network. Where competition is allowed in the provision of services, the number of potential equipment purchasers increases, raising demand for communications equipment and providing more opportunity for market entry. Finally, and perhaps most significantly, separating the service provider from the regulatory authority and removing it from the government budget forces the provider to operate more efficiently, and, in some cases, to earn a profit. As a result, price and quality become more important factors in equipment procurement decisions, and the nationality of the supplier becomes less important.

In the United States

The regulation of communications services in the United States is based on the Communications Act of 1934 and its amendments. The Communications Act established both the Federal Communications Commission (FCC) and the jurisdiction of state regulators over intra-State communications service. One primary purpose of the Communications Act of 1934 was to ensure that communications service was provided to the public on a nondiscriminatory basis and at reasonable prices. The Communications Act also charged the FCC with the regulation of "interstate and foreign commerce in communication by wire and radio" in order to make available "a rapid, efficient, nationwide, and world-wide wire and radio communication service."[22]

For most of the century, regulation of communications services was largely structured by the terms of the 1934 Communications Act. The FCC endorsed a policy of universal service, and telephone rates were set by State public utility commissions through rate-of-return[23] regulation. AT&T controlled nearly all of the long distance market through AT&T Long Lines and about 80 percent of the local exchange market through the BOCs.[24] In addition, AT&T held a considerable share of the equipment market through its captive supplier, Western Electric. Equipment that was not owned by the telephone company was not permitted to be attached to the system.

This situation began to change in 1956 with the FCC Hush-a-Phone decision that initiated the use of the "no harm to the network" test to allow non-AT&T equipment to be attached to the network.[25] The subsequent FCC Carterfone ruling of 1968 established the customer's right to own equipment, such as telephone sets, and permitted the attachment of private equipment to the public network, if the telephone company could not prove that it would harm the network. Under the terms of the Carterfone ruling, AT&T could still require that non-AT&T equipment use a connecting device to attach to the network. Since the cost of the connecting device was typically greater than the cost of leasing an AT&T telephone, the Carterfone decision had only limited practical impact on the U.S. market for customer-owned equipment.

Despite limitations, the Hush-a-Phone and Carterfone rulings are important to the development of U.S. regulatory policy because they represent the beginnings of a trend to disassociate equipment supply from the provision of services. The pivotal change occurred in 1976 when the FCC allowed direct electrical connection to the network for all equipment that was registered with the FCC under the registration program, or part 68 provisions.[26] Although the part 68

[20] "Telecommunications Services in a Global Marketplace," address by Hans Peter Gassmann, of the OECD, to the Conference on U.K. Telecommunications Policy, London, April 9-10, 1991, p. 2.

[21] Ibid, p. 4.

[22] 47 U.S.C. 151 (1976).

[23] Rate of return in this context refers to the percentage of net profit which a telephone company is authorized to earn on its total invested capital.

[24] Crandall, p. 17.

[25] Hush-a-Phone is a product name for an acoustic device which attaches to telephone handsets.

[26] Part 68 provisions are the FCC rules regulating the direct connection of nontelephone company provided equipment to the public network. These rules establish the minimum acceptance protection communications equipment must provide the telephone network.

Figure 4-2
Selected Regulatory Laws and Policies in Certain Major Equipment-Producing Countries

COUNTRY	YEAR	REGULATIONS	COVERAGE
UNITED STATES	1934	Communications Act of 1934	• Created the Federal Communication Commission to regulate "in the public interest" all forms of telephone, telegraph, and wireless communication
	1956	Hush-A-Phone Decision	• Permitted the attachment of an alien device to telephone equipment
	1959	FCC Decision on 890 mhz	• Authorized the use of frequencies above 890 mhz by private users
	1968	Carterfone Decision	• Established the customer's right to own equipment, such as telephone sets • Permitted equipment to be attached to the public network, provided it caused no harm to the network
	1969	MCI Decision	• Licensed MCI to build and operate an interstate radio network connecting business users in St. Louis and Chicago
	1971	Specialized Common Carrier Decision	• Expanded the scope of the 1969 MCI Decision allowing greater access and easier entry into the communications services market
	1974-1977	FCC Order Registration Program	• Established a registration program for communications equipment • Registered equipment could be connected directly to the telephone system
FRANCE	1990	Law of July 2, 1990	• Separated the regulation of the telecommunication sector and the operation of the network • Made France Telecom an autonomous state-owned entity • Replaced Mission a La Reglementation Generale (MRG) with the Directorate of General Regulation (DRG) as the main telecommunications regulatory body
	1990	Law of December 1990	• Defined the new licensing condition and regulatory framework
GERMANY	1989	Poststrukturgesetz (Postal Structure Law)	• Separated the Deutsche Bundepost Telekom which provides telecommunications services from the Deutsche Bundepost • Established the Federal Ministry of Posts and Telecommunications as the main regulatory body for equipment approval and rate setting
	1990	First Phone Rule Abolished	• Allowed approved equipment suppliers to sell in the German market
UNITED KINGDOM	1981	British Telecom-munications Act	• Separated telecommunication services from the British Post Office • Established British Telecom as a state-owned monopoly
	1982	British Approvals Board for Telecommunications (BABT)	• Secretary of Trade and Industry establishes an independent body to test terminal equipment; effective liberalization of terminal equipment
	1984	Telecommunications Act of 1984	• Created a regulatory framework which is based on licensing system • Established a regulatory body, OFTEL

Figure 4-2—Continued
Selected Regulatory Laws and Policies in Certain Major Equipment-Producing Countries

COUNTRY	YEAR	REGULATIONS	COVERAGE
JAPAN	Dec. 15 1948	MPT Foundation Law	• Defined the duties, power, and organization of the Ministry of Posts and Telecommunications
	Apr. 1 1985	Telecommunications Business Law	• Established the conditions for offering competitive communications services in Japan • Limited foreign ownership of public networks to 30 percent
	Apr. 1 1985	NTT Corporation Law	• Established a procedure whereby NTT would be privatized

Source: Compiled by the staff of the U.S. International Trade Commission.

program encouraged the entry of alternate equipment suppliers, the divestiture of AT&T accelerated the process and changed the nature of the communications equipment market.

As noted in "Antitrust Policy" section above, the Department of Justice filed an antitrust suit against AT&T in 1974 that was settled by the entry of a consent decree known as the MFJ. The MFJ thus completely separated the BOC communications services monopoly from AT&T, the principal manufacturer of communications equipment. The result was a rapid growth in the number of manufacturers, both foreign and domestic, competing in the U.S. communications equipment market. The number of part 68 applications indicates the scope of the entry into the equipment market that took place after the resolution of the MFJ in 1982 and the divestiture of AT&T in 1984. Annual part 68 applications nearly doubled, from 1,100 in 1982, to 2,200 in 1983, and jumped to 2,900 in 1984.[27]

Although changes in the regulation of communications services between the 1950s and 1980s clearly led to significant liberalization of the communications equipment market in the United States, pressure for change did not originate in either the services or government sector. Technological developments in microwave transmission, fiber optics, and switching capabilities made a competitive service market and regulatory reform possible. Users, by demanding specialized services and lower costs made possible by this technology, became one of the strongest forces advocating the reduction of communications regulation. An early example of user-driven deregulation is the FCC's 1959 Above-890 decision that allocated frequencies above 890Mhz for large private microwave communications systems operated by firms independent of AT&T and the Bell System. Following that, the FCC's 1969 MCI decision and 1971 Specialized Common Carrier Ruling (SCCR) licensed independent operators to build and operate an inter-State radio network connecting business users, allowing greater access to and easier entry into the communications services market. The SCCR required AT&T to grant independent service providers access to the local network, paving the way for independent common carriers to offer business clients special long distance services for the transmission of voice and data.

Outside the United States

In most countries, the arm of the government that provided communications services has been self-regulating. These state-owned service providers not only have been the most significant purchasers of communications equipment in their countries but also responsible for determining standards and certification procedures for all communications equipment. In effect, they controlled both the equipment and services markets and used their purchasing power to benefit domestic equipment producers.

Many foreign governments view regulation of communications as necessary, not only to ensure that reliable service is provided throughout the country, but also to promote national manufacturing industries, employment, and technological development.[28] In addition, some governments regard the communications service industry as a reliable source of revenue. Because governments pursue different goals, some have adopted regulatory schemes that advance social or economic programs at the expense of the communications services industry and the consumer.[29] Many governments employ policies that maintain communications services prices far above costs to

[27] Federal Communications Commission, "Brief History of Part 68," *Instructions for Form 730: Registration of Telephone and Data Equipment*, April 1991.

[28] North American Telecommunications Association, *EuroTelecom 1992*, 1990, p. 27.

[29] Peter F. Cowhey, "Telecommunications," p. 160 and E. Sciberras and B. D. Payne, *Telecommunications Industry*, pp. 54-63.

provide revenues to support domestic industries, education, or social programs.[30]

Recent structural changes in communications service industries in many countries have separated service providers, certification authorities, and regulatory bodies. These changes were accompanied by liberalization of regulation and, in some cases, privatization of communications service providers. The changes largely responded to user demands for better and more sophisticated services at reasonable prices and government attempts to stimulate the economies by modernizing the communications infrastructure.

Other changes in regulation of terminal equipment and new services are opening up new opportunities for communications equipment manufacturers by allowing more service providers to enter the market. Although few countries permit any competition in the area of basic communications services, many countries allow competition in small but rapidly growing mobile and value-added services. Around the world, terminal equipment markets are being deregulated, and multiple suppliers have begun selling directly to users.

The European Commission liberalized the EC market for communications equipment by issuing a directive ending the telecommunications authorities' monopoly over the provision of customer-owned terminal equipment.[31] Currently, all member states except Belgium have eliminated the "first phone" rule that required consumers to purchase the first telephone from the telecommunications authority.[32] In order to eliminate internal trade barriers and insure a single market for terminal equipment, the EC Council of Ministers formally adopted a directive that provides for the mutual recognition of type approval for terminal equipment.[33] As stipulated in the directive, member states must take the measures necessary to comply with this directive no later than November 6, 1992. In preparation for 1992 integration, it is expected that certain EC directives will encourage regulatory harmonization throughout Europe. In conformance with the 1987 Green Paper on Telecommunications, the EC Council of Ministers adopted the open network provision (ONP) directive (90/387) on June 28, 1990.[34] This framework directive is designed to be followed by more specific directives creating harmonized telecommunication regulations among EC member states.[35]

In 1981, the British Government began to deregulate and liberalize the operation of communication networks, the provision of communications services, and the supply of communications equipment to a greater extent than any other European nation. In 1984, British Telecom was transformed from a state corporation with monopoly rights to a private corporation open to competition. In 1984, Mercury Communications began offering national and international long distance telephone service as well as some local service. In addition, competition was permitted in the telex, data, and cellular service markets.[36] Other European countries are following suit, although not as quickly or as comprehensively as the United Kingdom. In the late 1980s, both France and Germany separated their regulatory authorities and service providers and began to liberalize their markets and change regulatory policy. Competition is now allowed in value-added, paging, satellite, and mobile radio services, and the sale and attachment of terminal equipment to the national network is now permitted.

The Government of Japan also began restructuring the nation's communications industry in the mid-1980s, shifting from regulated, government-owned monopoly to a more competitive structure. Some steps have been taken toward privatization of the principal communications service provider, NTT, and introduction of competition in some segments of the Japanese communications services industry outside of basic local and long distance service. New competitors in the Japanese market include foreign service providers, such as EDS, AT&T, and Tymnet, especially in the international and data network service sectors of the market.[37]

Research and Development Policies

The national governments of the industrialized nations have long contributed to research and

[30] Ibid and Allen R. Frischkorn, Jr., Telecommunications Industry Association, comments before the U.S. International Trade Commission on investigation No. 332-267, July 6, 1990.

[31] EC Commission, Directive 88/301, *Official Journal of the European Communities (OJ)*, No L 131 (May 27, 1988), pp. 73-77. In passing this directive, the European Commission used article 90(3) of the Treaty of Rome, which allows it to issue directives on the basis of competition rules of the Treaty without first having the directive approved by the EC Council of Ministers. After EC member states were notified of this directive, the Governments of France, Belgium, Italy, and Greece challenged the use of article 90 claiming that the European Commission overstepped the powers of the Council of Ministers. In March 1991, the European Court of Justice upheld the EC Commission use of article 90 and required that all member states comply with the directive.

[32] U.S. Department of Commerce officials, interviews by USITC staff, September 1991.

[33] EC Council, Directive 91/263, No. L 128 (May 23, 1991), pp. 1-18. For further discussion of this directive, see section on Trade Policies.

[34] EC Council, Directive 90/287, No. L 192 (June 28, 1990).

[35] For an analysis of this and other telecommunications directives in the EC, see USITC, *The Effect of Greater Economic Integration Within the European Community on the United States* (investigation No. 332-267), USITC publication 2268, March 1990, USITC publication 2318, September 1990, and USITC publication 2368, March 1991.

[36] British Telecom, *Annual Report on Form 20-F 1990*, filed with the U.S. Securities and Exchange Commission on September 17, 1990, p. 17.

[37] U.S. industry officials and representatives of the Government of Japan, interviews by USITC staff, February and April 1991.

development (R&D)[38] either financially or through the activities of government laboratories. This section discusses the influence of government support for R&D on the communications equipment industry.[39] The close relationship between communications services and the government in most nations and the strategic importance many governments place on information technology have made government R&D policies particularly significant to the communications equipment industry. However, major R&D policy differences exist between the United States and its competitors in the communications equipment industry. Before addressing communications-specific differences in R&D policy, this section briefly compares the general structure of R&D support across nations.

General Policy Structure

All MEP countries have policies to influence or promote general R&D activities. The goals of R&D policies are to promote economic growth through innovation-led productivity improvements and to encourage additional R&D activity if privately funded R&D is insufficient to meet society's needs. Figure 4-3 indicates the relative size of this support in MEP countries. In France and the United States, more than half of all funds spent on R&D are supplied by the Government. The Governments of these two countries also contribute significantly to R&D performed by private industry—21 percent in the case of France and 33 percent in the United States. Government financial support for R&D in Japan is the lowest of the seven countries presented, accounting for only 21 percent of total R&D and 2 percent of private industry efforts.[40]

Government support for R&D as a percent of total government expenditures falls into a fairly narrow range—roughly 3 to 5 percent—in the seven countries shown in figure 4-4. This ratio remained fairly stable in each country between 1975 and 1985. The major international differences occur not in the level, but rather in the direction and method of funding.

Government funding in the United States has constituted a significant portion of national, as well as industrial, R&D spending. U.S. Government funding accounts for nearly half of national R&D expenditures and near one-third of industrial expenditures. However, as table 4-1 indicates, Government R&D support in the United States remains far more concentrated in defense research projects and less concentrated in industrial development research than does support in other industrialized nations.[41] Government funds also contribute a significant portion of R&D spending in Canada, France, and the United Kingdom. Japanese R&D, in contrast, relies heavily on private financing of R&D—more so than in any other industrialized nation. However, much of Japan's official support for R&D is through Government direction rather than Government funds. The Japanese Government promotes technological development in the private sector through high visibility government studies, committees, and campaigns that focus attention on certain technologies.[42]

The United States has directed its research investment toward basic and defense-related research, while other nations have focused more on applied and industry-specific research. The United States is the only country listed in table 4-1 that directs a majority of its R&D funding to defense. Further, over three-quarters of the funding that the U.S. Government provides to industry is defense-related. France, the United Kingdom, and Sweden, however, also direct a large portion of government-financed industry R&D to defense. The support for industry R&D provided by the Japanese Government is relatively small because most government support for R&D in Japan is channelled through universities.[43]

Historical reasons as well as economic factors account for some of the differences in R&D focus between the United States and other equipment-producing countries. Germany and Japan face restrictions on the size of their defense industry and consequently set aside little R&D funding for defense projects. This factor together with the need to rebuild and reestablish an industrial base after World War II prompted European and Japanese Governments to direct R&D funding toward commercial projects.

The ability to retain a technological and economic lead through basic and defense-related research influenced R&D policy in the United States.[44] Prior to the 1980s, U.S. firms were able to retain most benefits of company and national R&D and to prevent competitors from appropriating them.[45] The benefits of R&D activity include product developments, new methods of manufacturing, productivity improvements, and cost reductions. The probability of retaining such R&D benefits solely within one nation or company decreased as the pace of technological change, the number of multinational companies, and the pressure

---

[38] The National Science Foundation (NSF) has defined *research* as "a systematic and intensive study directed toward a fuller knowledge of the subject studied" and *development* as "the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems, methods, or processes." U.S. Bureau of the Census, *Statistical Abstract of the United States*, 10th ed., Washington, DC, 1990, p. 581.

[39] Private R&D efforts in the industry are discussed in chapter 4.

[40] OECD, *Science and Technology Indicators Report #3*, Paris 1989, table 15 and OECD, *Industrial Policy in OECD Countries: Annual Review 1990*, Paris, 1990, table 47.

[41] International comparisons of R&D data are often difficult since each country establishes its own method of accounting for R&D expenditures. The U.S. methodology is established by the Financial Accounting Standards Board (FASB). The OECD has attempted to standardize the various methodologies in its *Frascati Manual 1980*.

[42] Porter, *The Competitive Advantage of Nations*, p. 415.

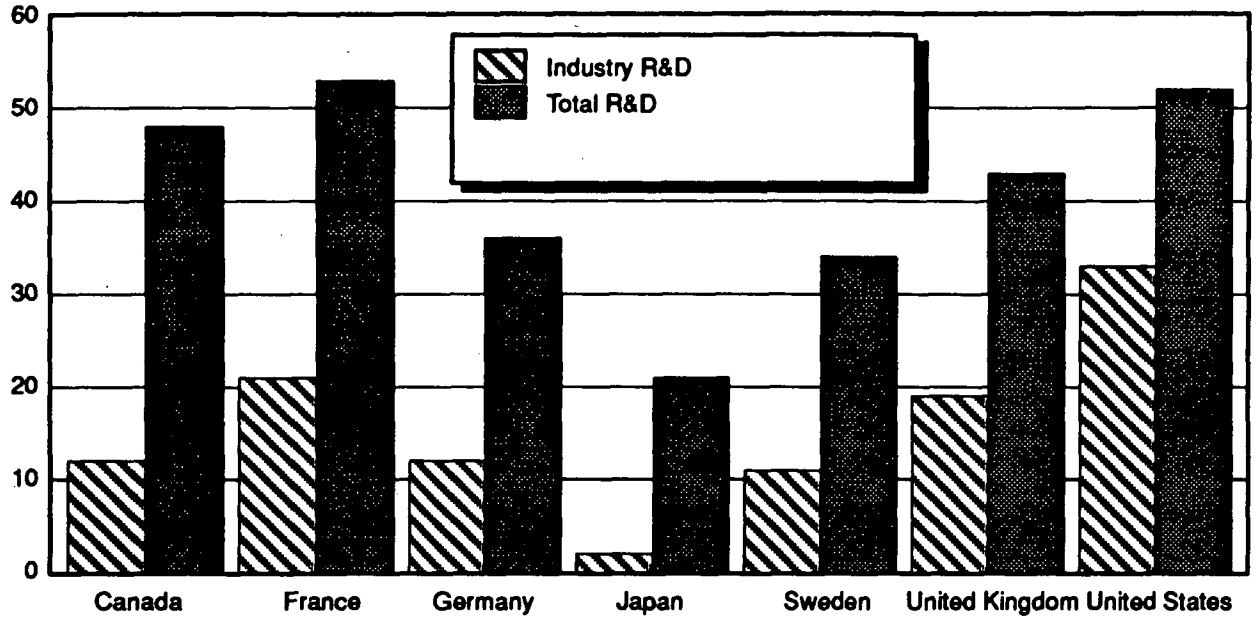
[43] OECD, *Industrial Policy in OECD Countries: Annual Review 1990*, p. 115.

[44] David C. Mowery and Nathan Rosenberg, *Technology and the Pursuit of Economic Growth* (Cambridge UK: Cambridge University Press, 1989), p. 218.

[45] Ibid.

Figure 4-3
Government share of R&D expenditures, industry and total, in selected countries, 1987

Percent



Note.—Total R&D expenditures for France, Japan, Sweden, and the United Kingdom are for 1985.

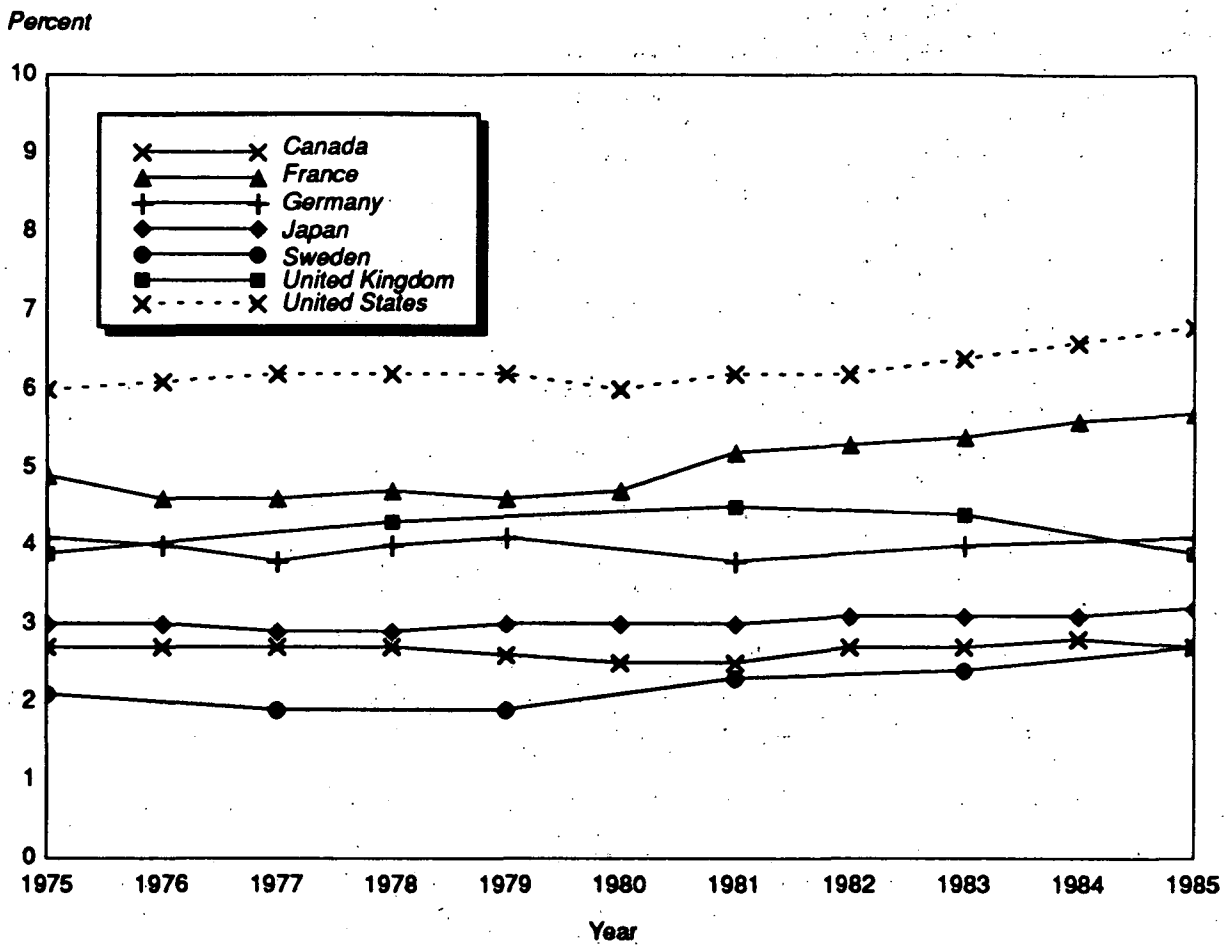
Source: OECD, Science & Technology *Indicators Report #3*, Paris 1989, Table 15, and OECD, *Industrial Policy in OECD Countries*, Paris 1990, Table 47.

Table 4-1
Government-financed R&D support to all research and to industry research, 1985

	To All Research		*To Industry Research*	
	Value	*Defense related*	*Value*	*Defense related*
	US $ (Million)	*(Percent)*	*US $ (Million)*	*(Percent)*
United States	55,145	58.6	26,470	77.0
Japan	8,413	2.6	505	0.0
Germany	7,435	12.2	2,454	32.9
France	7,709	34.6	2,004	65.2
United Kingdom	6,237	48.5	2,121	84.1
Canada	2,616	6.3	340	17.1
Sweden	1,001	24.1	240	69.2

Source: OECD, *Science and Technology Indicators Report #3*, Paris 1989, Tables 13, 27, 30, and 31.

Figure 4-4
Government R&D expenditures as a percent of all government spending in selected countries, 1975-85



Source: OECD, *Science and Technology Indicators Report #3*, Paris 1989, Tables 13 and 26.

of foreign competition increased the capacity for international technology transfer.

The R&D policies of the United States' major competitors have accommodated this environment by directly supporting commercial and industrial research projects. Furthermore, many governments have recognized the strategic importance of certain technological areas, such as communications, and have focused support on them to maximize the benefits of government-supported R&D to the national economy. As a result, U.S. competitors have been able to improve their technological base and collect the economic benefits of R&D by focusing on industry-specific research and on the commercialization of innovation.[46] The U.S. focus began to shift in the 1980s. By the final years of the decade, several initiatives, such as Sematech and the National Institute of Standards and Technology (NIST) Manufacturing Technology Centers, had been established to promote industry-specific research and to exploit the commercial potential of basic research innovations.

Support For Industry

Government R&D policy in many nations, with the exception of the United States, allocates funds or offers special incentives to the communications equipment industry. Specifically, government involvement with national communications service providers and targeting of communications as a "strategic" industry may have important implications for R&D in the communications equipment industry. Figure 4-5 at the end of this section lists the major national and regional organizations for communications R&D, all of which receive some or all of their funding from government sources, and indicates size, research focus, and connection to equipment manufacturers.

[46] Ibid. and Nelson, pp. 33-41.

Figure 4-5
Communications R&D Organizations and Programs International Comparison

Country Region	Communications R&D Organizations & Programs	Size	Support For R&D Of Equipment Manufacturers	Communications Research Focus
CANADA	*Bell Northern Research* Jointly owned by Bell Canada, 30%, and by Northern Telecom, 70%.	9 labs, 6000 employees, $643.1 million budget (1987)	Serves as main R&D facility for Northern Telecom	Network technology, switching, transequipment
FRANCE	*National Center for Telecommunications Studies (CNET)* Subsidiary of France Telecom	4314 employees in 1987	Collaborative R&D and "buying" of prototypes made to DGT specifications	———
JAPAN	*NTT Laboratories* Government owns majority of NTT stock	6000 employees and 8000 patents	Exchange of research staff with suppliers	Digital technologies, intelligent processing technologies, nanoelectronics, and optoelectronics
	Basic Technological Research Promotion Center (BTRPC) Created by the government in 1985 with sales of NTT stock	———	Conducts research and assists joint R&D projects between private companies.	Information technology
	Key Technology Center Part of BTRPC.	60 employees, $215 million budget in 1990	Provides up to 70% of capital investment for joint R&D ventures. Only the principal must be repaid if the project fails.	Fundamental technologies which include telecommunications technology
	Telecom Research Parks Established by the government in 1986.	———	Regional research facilities for collaborative projects between private firms; the parks include equipment and utilities; often available are a clean room, a room insulated from radio waves, a large-scale computer, and a library	Telecommunications
SOUTH KOREA	*Electronics and Telecommunications Research Institute (ETRI)* Joins together the Korea Institute of Electronics Technology (KIET) and the Korea Electro-technology and Telecommunications Research Institute (KETRI)	1,200 employees, $90 million budget in 1989	Principle research arm of Korea Telecommunications. Carries out collaborative R&D with Korean manufacturers in the areas of communications and computers	Product and process development of information technology; the development of communications protocol for ISDN, optical transmission devices,and an earth station satellite
SWEDEN	*Ellemtel* Joint venture between Teli, the manufacturing subsidiary of Swedish Telecom, and Ericsson	———	Products developed by Ellemtel are manufactured by Teli for the Swedish market and by Ericsson for the international market	———
	R&D at Swedish Telecom	3.5% of sales in 1989 (1/4 for research and 3/4 for development)	———	Image coding, optical broadband networks, data communication protocols, software, expert systems, and mobile communications

Figure 4-5—Continued
Communications R&D Organizations and Programs International Comparison

Country Region	Communications R&D Organizations & Programs	Size	Support For R&D Of Equipment Manufacturers	Communications Research Focus
UNITED STATES	*Bell Labs* Privately Funded by AT&T	Budget of $2.4 billion in 1990		
	Bellcore Created and funded by the RHCs	Budget of $1.1 billion 1990	Generic technology procurement support and open access to technology specifications	Operations systems and automation, fiber optics, and advanced television standards
UNITED KINGDOM	*Martlesham Heath Labs of British Telecom*	3000 researchers. BT spent 228 million pounds on R&D in 1990	Collaborative research. About 1/2 of research budget is for contract research with industry and universities	Public switching and transmission equipment as well as telephones, PBX, and other products
	LINK Program Financed by the Department of Trade and Industry	22 projects and 89 million pounds in 1988-89	Collaborative research between industry and science	Two of the largest LINK programs are in optoelectronics systems (15 million pounds) and personal communications (6.35 million pounds); optoelectronics focuses on optical communications and information processing; personal communications on mobile radio, satellite mobile systems, & cordless telephones
WEST GERMANY	*FTZ* Telecommunications engineering center of the DBP	Over 2500 engineers	Collaborative R&D, assists with field trials of new equipment, and purchases equipment at high prices	Digital networks, fiber optics, software, and basic research
EUROPEAN COMMUNITY	*European Strategic Program for Research and Development in Information Technology (ESPRIT)* Begun in 1984, it is the largest of the EC Framework Programs.	ESPRIT I: ECU, 1.5 billion 200 projects, 450 participating firms (including US firms), and 3000 researchers	Collaborative R&D	Information processing services and microelectronics
	Research and Development in Advanced Communication Technology for Europe (RACE) Also a Framework Program.	Total funding 1987-91 is ECU 1.1 billion; 48 projects begun in 1988, 40 projects begun in 1989	Collaborative R&D with the goal of creating a strong equipment and service industry so that Europe can be a major player in the world communications market	Objective is the development of an integrated broadband communications (IBC) system based on ISDN. Involvement in standards setting and harmonizing diverse regulatory regimes

Source: Compiled by the staff of the U.S. International Trade Commission.

Communications Service Providers

As the largest consumer of communications equipment and one with customized needs, communications service providers play an integral part in the direction and funding of R&D in the communications equipment industry. Consequently, government policy on the structure of the communications services industry also affects the communications equipment industry.

When the communications service provider is owned or controlled by the government, government policy often attempts to ensure technological advances in the private communications equipment industry through preferential procurement policies and through collaboration with the service provider's own R&D activities.[47] Communications service providers with government-granted monopoly rights may take advantage of their position to extract high monopoly profits to fund R&D directly. In addition, they may fund R&D indirectly by paying higher-than-average prices for communications equipment.[48] Although this type of government support is indirect, it has a significant influence on the industry's ability to perform R&D activities.

The involvement of communications service providers with equipment R&D has become a particularly contentious issue in the United States. The MFJ, which stipulated the terms of the AT&T divestiture, prohibited the RHCs from manufacturing, designing, or developing communications equipment in the United States. As part of this restriction, the RHCs must publicize their equipment standards and are not allowed to establish sole-source contracts with their equipment suppliers. Some equipment providers believe that this restriction promotes competition and technological development by preventing RHC affiliations with one or two manufacturers.[49] Other suppliers, as well as the RHCs, argue that the restriction discourages RHCs from funding R&D in the United States and inhibits the transfer of their technological knowledge to equipment providers because product designs or developments cannot be proprietary.[50] From either viewpoint, the government policy embodied in the MFJ is seen as having a major impact on R&D investment in communications equipment.

[47] Sciberras and Payne, pp. 54-63.

[48] Ibid. and Robert W. Crandall and Kenneth Flamm, *Changing the Rules: Technological Change, International Competition, and Regulation in Telecommunications* (Washington, DC: The Brookings Institution, 1989), pp. 258-9.

[49] See, for example, "The Post-Divestiture U.S. Telecommunications Equipment Manufacturing Industry: The Benefits of Competition," A collaborative study by IDCMA, the North American Telecommunications Association, and the Telecommunications Industry Association, pp. 13-15.

[50] See, for example, David J. Markey and Robert T. Blau, "Is the AT&T Consent Decree Strangling American R&D?" *Telematics*, August 1986, pp. 3-8.

Targeted Industrial Programs

Economic growth is often stimulated by technological innovations and productivity improvements made by a leader industry, such as the textiles industry in the 19th century and the automobile industry in the early 20th century.[51] In this context, governments often support R&D in leader industries as part of an overall policy to promote national growth. Information technology is typically considered a strategic part of the industrial development plan. Information industries, including communications, are seen as leader industries, and research for these industries is given special encouragement.

For example, the Strategic Technologies Program in Canada provides financial assistance for R&D projects concerning advanced materials, biotechnology, or information technologies undertaken between companies and research institutions.[52] Most communications technology research supported by the EC is conducted under the auspices of the Framework Research and Development Programs. Although the focus of the First Framework Program was on energy research, the largest budgetary increase in the Second Framework Program was for information and communications technologies, which together accounted for over 40 percent of the total budget.[53] Two large Framework Programs, ESPRIT and RACE, focus on communications and information technologies.[54]

Japan places special emphasis on communications technology and has taken several steps to indicate its importance. It has been specified as a "fundamental technology" in the Law for the Facilitation of Research in Fundamental Technologies along with mining and manufacturing technology, and MITI has recognized the industry as important in its "Visions" of the Japanese economy.[55] In 1986, the Government provided tax incentives for private companies to participate in a Ministry of Posts and Telecommunications (MPT) communications infrastructure initiative and a MITI "information- oriented society" infrastructure initiative. Legislation offered a 13-percent special investment tax credit in the first year to private companies participating in designated projects and certain exemptions from property and land sales taxes.

[51] See the discussion of the theories of Joseph Schumpeter and Nikolai Kondratiff in Richard R. Nelson, *High Technology Policies: A Five Nation Comparison*, pp. 1-2.

[52] OECD, *Industrial Policy in OECD Countries: Annual Review 1990*, p. 24.

[53] USITC, *The Effect of Greater Economic Integration*, USITC publication 2318, pp. 16-6

[54] ESPRIT is the European Strategic Program for Research and Development in Advanced Information Technology and RACE is the Research in Advanced Communications Technologies in Europe program.

[55] Based on documents received from the Embassy of Japan.

There is some evidence that concentrated assistance has benefited the targeted areas. For example, experts believe that Japanese Government support of optoelectronics has helped push Japan ahead of the United States in this field.[56] Between 1979 and 1985, this support included NTT research in fiber optics applications and national technology development projects with budgets of $160 million for optoelectronic technologies and $709 million for optical information processing. In addition, the Joint Optoelectronics Research Lab (JOERL) used 50 researchers from participating Japanese companies to focus on developments at the materials and components level of fiber optic and optoelectronics systems.[57]

In contrast with its major competitors, the United States does not support communications R&D as part of a targeted industrial program. Although agriculture, the aerospace industry, and the space program serve as exceptions, the U.S. Administrations have generally opposed strategic industrial targeting. Most R&D assistance available to communications equipment manufacturers is through industry-neutral programs such as the research and experimentation tax credit and the Government's basic research laboratories. The benefits to communications technology that result from work in government laboratories are typically unintentional spillover benefits—such as developments in fiber optics resulting from the Strategic Defense Initiative (SDI)—and are thus not always efficiently transferred to industry.

Tax Law and Policy

Corporate tax systems are complex, and a comprehensive description or analysis of differences among countries is well beyond the scope of this section. Accordingly, this section is limited to a brief description of key features of U.S. and foreign corporate tax laws, with an emphasis on those provisions identified by the U.S. telecommunications industry as being important to the well-being of the industry. With respect to the United States, this section focuses on U.S. Federal tax law; however, it should be noted that States and localities within the States impose taxes of various kinds, including income taxes, that, though generally lower than those at the Federal level, may be significant in magnitude.

Like U.S. tax law, foreign tax laws tend to be intricate and reflect social custom, practical considerations in collection, and government policy. Direct comparisons between U.S. and foreign tax laws, particularly with respect to general corporate tax rates or industry-specific deductions such as depreciation, tend to be very difficult and may be meaningless if not placed in the broader context of the entire tax system. For example, a country with a high nominal rate on taxable income but with many opportunities for deductions and credits may have a lower effective rate of tax than another country with a much lower nominal rate but fewer opportunities to take deductions or credits. Local taxes levied on corporations are often significant; the trade tax levied on corporate income by localities in Germany raises about the same amount of revenue as the German Federal corporation tax. In addition, some countries, for example, those in the EC, rely relatively heavily on indirect taxes, such as value-added and excise taxes, and are less dependent on direct taxes, such as corporate and personal income taxes.

Tax policy with respect to R&D, depreciation, and capital gains treatment is regarded as important to investment. Tax provisions with respect to each of the three can affect the competitiveness of communications equipment manufacturers. An effective R&D tax credit may provide an equipment manufacturer with the ability to finance a long-term research plan through tax credit savings that will improve competitiveness. Reduced tax rates for long-term capital gains can help firms raise capital through sale of stock by making the investment attractive to long-term investors. Finally, depreciation rates define the cost recovery period for investment; the longer the period, the longer the purchaser is likely to wait before buying new and more modern equipment.

R&D Tax Credits

U.S. tax law allows a 20-percent tax credit on qualified research expenses that exceed the average amount of the taxpayer's yearly qualified research expenses in the base period, generally, the preceding 4 taxable years.[58] The term "qualified research" covers both in-house and contract research expenses.[59] However, the law is temporary rather than permanent, and is presently scheduled to expire December 31, 1991. Industry representatives argue that long-term investments such as research are not adequately encouraged by a temporary credit. A working paper of the Ad Hoc Electronics Group on R&D and Capital Formation advocates making the credit permanent as an incentive to industry to adopt a longer term planning horizon stating:

> Inconsistencies and uncertainties in U.S. tax provisions relating to R&D expenditures do not permit American industry to plan for R&D investments over the long run. Short-term extensions of the credit, sometimes after it has already expired, undermine industry's ability to plan for the future.[60]

Similarly, the Telecommunications Industry Association (TIA) has stated that although the R&D

[56] Christopher Johnson and Joseph E. Flynn, "The Race for Photonic Leadership," *Photonic Spectra*, February 1991, p. 78.
[57] Ibid.

[58] 26 U.S.C. 41(a) and (c).
[59] 26 U.S.C. 41(b)(1).
[60] Ad Hoc Electronics Tax Group, "Working Paper on Research and Development/Capital Formation," Spring 1990, p. 1.

tax credit has provided "substantial benefit" to manufacturers competing in the communications industry, making it permanent would provide greater assurances of tax consequences of R&D, reducing the risk associated with these activities.[61] The incremental nature of the R&D tax credit has also been criticized. Because the amount of the credit depends on comparing current expenditures to past expenditures, the decision to increase R&D spending in any one year will decrease the size of the credit in future years. By tying the expenditures in different years together, the R&D tax credit formula increases the risk and uncertainty associated with R&D investment.[62]

Like the United States, Japan has adopted tax policies designed to stimulate research and development, but Japanese incentives tend to be more directed to specific sectors.[63] The dispensation of tax incentives permits MITI to allocate incentives as it deems appropriate, a practice that allegedly favors high-technology industries and other industries that the Japanese Government is seeking to encourage. Industry sources report Japan has 19 different tax incentive systems to encourage technological innovation, including an R&D tax credit similar to that of the United States. For example, between 1985 and 1988 a Key Technologies tax credit was in effect, equal to 7 percent of the acquisition cost of assets used in specified technologies or 20 percent of the corporate income tax, whichever was greater.

Capital Gains

Since passage of the Tax Reform Act of 1986, most long-term capital gains have been taxable at ordinary income rates. Many firms have argued that the elimination of lower rates on long-term gains has made it more difficult to attract equity capital. Unlike the United States, many developed countries[64] do not tax individuals on their long-term capital gains; others tax them at a rate substantially below that for ordinary income.[65] Of course, the significance of either the non-taxation or lower taxation of such gains in other countries varies with the effective tax rates in those countries.

[61] Comment of the Telecommunications Industry Association to the National Telecommunications and Information Administration of the U.S. Department of Commerce, April 9, 1990, p. 21.

[62] U.S. industry officials, interviews with USITC staff, August 1991 and Council on Research and Technology, "A Permanent R&D Tax Credit," CORETECH Policy Council Update, 1989, p. 2.

[63] The material in this paragraph is from T. Howell et al., *The Microelectronics Race: The Impact of Government Policy on International Competition*, 1988, pp. 67, 132-33.

[64] Including Germany, Switzerland, Korea, Taiwan, Italy, Belgium, and the Netherlands.

[65] Japan taxes long-term capital gains at a rate of 5 percent, and Sweden taxes gains on assets held over 2 years at a rate of 18 percent.

Depreciation

Rules regarding depreciation can affect capital spending on the telecommunications infrastructure. U.S. communications service providers advocate shorter depreciation periods to increase the turnaround of funds available for investment and replacement of technologically obsolete equipment. Computer-based telephone CO switching equipment is depreciated over 5 years and telephone distribution equipment over 15 years.[66] Other countries permit equipment to be depreciated over shorter periods. Longer depreciation schedules for communications infrastructure may delay replacement of equipment and, consequently, modernization of the network.

Intellectual-Property Rights

This section presents an overview of the intellectual property laws and policies of the United States, the European Community, and Japan. Intellectual property protection include patents, trademarks, copyright, and mask works. In the communications industry, patents are important in protecting inventions of communications equipment and copyrights are important in protecting software. This section briefly reviews how intellectual property rights have affected the communications equipment industry and provides a synopsis of domestic and foreign laws and policies.

Laws and Policies

United States

In the United States, both patent and copyright law have played an important part in the development of the communications equipment industry. There are two categories of patents relevant to the communications equipment industry: utility patents and design patents. Utility patents are granted for new and useful processes, machines, and products, and are issued for 17 year terms. Design patents are granted for new, original, and ornamental designs for articles of manufacture and are issued for 14 year terms. The owner of a copyright generally has the exclusive right to "original work of authorship" for the life of the author plus 50 years.

Patent and copyright infringement disputes in the United States are settled in Federal Courts or at the U.S. International Trade Commission in administrative proceedings brought against infringing imports. Furthermore, the United States Customs Service may seize imported articles which infringe U.S. copyrights.

European Community

There is no comprehensive, Communitywide patent or copyright law in the EC. Each of the member states grants patents on the basis of at least a formal examination in the national patent office or in the

[66] 26 U.S.C. 168(e)(D)(ii).

European Patent Office; copyright protection begins with creation of the work. The national laws of some member states exclude certain subject matter, such as computer programs, from patentability. However, many member states grant copyrights for computer software. With a few exceptions, patent terms in the member states are 20 years from the date of filing. Copyright generally extends for the life of the author plus 50 years. All member states provide for actions for patent and copyright infringement in a trial court, sometimes called a court of first instance. The broad pre-trial discovery, characteristic of litigation in U.S. courts, is virtually unknown in continental European courts and permitted only on a limited basis in the courts of the United Kingdom and the Republic of Ireland. Appeals are usually possible in such actions, and remedies may include a permanent injunction and damages.

The member states of the EC have concluded, but not yet ratified, a Community Patent Convention that would create an EC-wide patent.[67] Furthermore, most member states of the EC and several non-member states are signatories to the European Patent Convention, which provides for centralized patent examination, under uniform standards, at the European Patent Office. The European Patent Office does not issue a supranational European patent, but rather a collection of national patents. Some harmonization of copyright law may result from the EC's 1992 program, as the EC Council has adopted a directive to treat computer software as literary works under national copyright law. All member states are signatories to the Universal Copyright Convention and, more importantly, to the Berne Convention, which provides for certain minimum levels of protection.

Japan

Japan grants patents for most subject matter. Applications for patents are made to the Japanese Patent Office, which conducts a formal and substantive examination only on request. If such a request is not filed within 7 years of the application date, the application is abandoned. If, after examination, the application appears otherwise allowable, it will be published and laid open for public inspection 18 months after application. The term of Japanese patents is 15 years from date of publication (not to exceed 20 years from date of application), with the possibility of up to 5 years extension. The average time for grant of a patent is 3 to 4 years, compared to about 20 months in the United States. Part of the reason for this is the relatively small number of examiners in the Japanese Patent Office and the existence of a pre-grant opposition procedure. Annual maintenance fees are charged to keep patents in force. Compulsory licenses may be granted if the invention is not actually used or worked, or, if necessary, to serve in the public interest.

[67] Spain and Portugal have not yet signed and Ireland and Denmark have not yet ratified the convention.

The claims granted in Japanese patents are relatively narrow compared with those granted in the United States. Furthermore, the doctrine of equivalents, as it is known in the United States, is not known in Japan. The narrowness of claims can result in a situation where competitors can file numerous applications on close variations of the claimed invention, a practice sometime referred to as patent "flooding." This can result in a patentee being hemmed in by the patents of a competitor, even in an area where he has pioneered, and a situation which may force cross licensing. An alternative course for the patentee is to file patent applications on those variations himself.

Japanese law provides for copyright protection for computer programs as literary works. No formalities are required to secure copyright. In general, the term of copyright is the Berne Convention standard, life of the author plus 50 years. The copyright or patent owner may bring an action for infringement in the high court, with possibility of appeal. Pre-trial discovery of the type known in the United States is not available in Japan. Remedies include permanent injunctions and damages. Provision is also made for criminal penalties.

Effect on the Industry

Patents and copyrights have an important effect on the competitiveness of firms in the communications equipment industry. From the origins of the telephone to current developments in the fiber optics industry, patents have often determined dominant suppliers in the communications equipment industry and granted significant leads to innovators in an environment of rapid technological change. However, as computer software becomes central to the technology of sophisticated communications equipment, copyright laws are gaining importance to both producers and consumers of these devices.

The original patents issued to Alexander Graham Bell for the invention of telephone technology were instrumental in establishing the modern communications industry. In fact, the components of what came to be the Bell system were established within a decade of the granting of the basic patent.[68] Throughout the century, many of the innovations in communications equipment were developed and patented by Bell Labs. Control over these patents was one factor that made AT&T the premier communications equipment manufacturer in the world throughout much of this century. However, in 1956, as a part of the consent decree, AT&T lost that control, as it was required to grant licenses for all prior and future patents. Prior patents were to be licensed royalty free and future patents were to be licensed at reasonable rates. This requirement was rescinded under the terms of the 1982 MFJ.

[68] Manley R. Irwin, "The Telecommunications Industry," *The Structure of American Industry*, edited by Walter Adams, (New York: Macmillan, 1990), p. 246.

Patents continue to influence the competitiveness of the industry, particularly in advanced technologies such as fiber optics. Patent rights have enabled the U.S. industry to dominate much of the world market for optical fiber. Corning Glassworks and AT&T jointly developed the technology, materials, and components used in fiber optic systems and are the largest U.S. producers of this type of transmission equipment. Corning and AT&T possess the basic patents for the production of optical fiber, and the firms have been able to influence much of the production and distribution of fiber in the United States, Canada, and, Europe through legal patent means and extensive licensing arrangements.[69] Japan is the only major country to refuse to grant Corning a patent for its optical fiber technology, which has permitted the Japanese producers to gain a dominant position in their home market.[70]

Legal protection for intellectual property can affect the pace and extent of technological development. The process of obtaining a patent is expensive and may take years. In fast-moving industries such as communications, lag time between patent application and issuance can be a problem. Before a patent is granted, another inventor may bring an infringing invention to market, unaware that one or more patents are pending. Copyright protection for software presents difficulties in that many countries have only recently begun to protect software and others do not yet grant any protection to software.

Because the communications equipment market is international and the principal producers are multinational companies, effective intellectual property protection would be promoted by some degree of harmonization of both patent and copyright laws at a sufficiently high level. The most extensive international patent treaty is the Paris convention of 1883, which is based on the principle of "national treatment." The corollary treaty for copyright protection is the Berne Convention, which is recognized by 70 nations and requires national treatment. Efforts are currently under way to include trade-related intellectual property rights in the General Agreement on Trade and Tariffs (GATT) to increase the protection and enforcement of these rights.

Trade Policies

Trade Barriers

Communications markets are relatively free of significant tariff barriers. Nontariff trade barriers affecting communications markets generally involve either standards, testing, and certification issues, or the procurement policies of telecommunications administrations. Although well defined standards often benefit both producers and consumers, incompatible standards and discriminatory testing and certification requirements may result in technical barriers to trade. Procurement policies of communications service providers favoring domestic suppliers have also been cited as trade barriers in the communications equipment industry.

Standards, testing, and certification

Standards are a means of uniformly defining and accurately describing products and their performance. Properly drafted standards contribute predictability and lower risk for both producers and consumers.[71] Standards are generally designed to protect consumers' health or safety or the environment. Manufacturers often support standardization because it allows them to achieve scale economies in production and may ease maintenance requirements if common componentry can be used in a variety of products.[72]

The rigor of national standards and testing methodology used to enforce compliance may create technical barriers to trade in the communications equipment industry.[73] Performance or regulatory standards are generally country specific and tend to divide the market along national boundaries. Incompatible technical standards lessen competition by locking purchasers into a limited number of suppliers and may be used to protect domestic industries. Similarly, lengthy, expensive, or nontransparent testing procedures may also slow or prevent market entry. In many nations, testing must be performed by national testing facilities, which often refuse to reveal the parameters examined during the test. Testing requirements may extend beyond the "no harm to the network" principal to include performance requirements or even performance restrictions. For example, standard U.S.-made PBXs must be modified before sale in Germany to eliminate certain features that are prohibited. Such restrictions can result in a machine that costs more but delivers less to the end user.

EC member states maintain different standards and test procedures. Such variations can inflate firms' market entry costs in entering these markets because products must be modified for each market then tested and certified by national testing agencies in each country before they may be sold. Taken together, the direct and indirect costs of divergent regulations and standards have been substantial. These costs amount to almost $6 billion in the EC telecommunications

[69] Because of the importance of these patents to the competitiveness of the U.S. industry, the major U.S. producers of optical fiber have engaged in extensive efforts to defend their intellectual property rights in global markets.

[70] U.S. International Trade Commission, *U.S. Global Competitiveness: Optical Fibers, Technology, and Equipment* (investigation No. 332-233), USITC publication 2054, 1988, pp. 3-7 to 3-13.

[71] USITC, *The Effects of Greater Economic Integration*, USITC publication 2204, July 1989, pp. 6-8.

[72] Carl F. Cargill, *Information Technology Standardization, Theory, Process, and Organizations*, Digital Equipment Press, 1989, p. 16.

[73] R. B. Cohen, R. W. Ferguson, and M. F. Oppenheimer, *Nontariff Barriers to High-Technology Trade* (Boulder, CO: Westwood Press, 1985), p 23.

industry, and may account for nearly 2 percent of annual overall manufacturers' costs.[74]

Unifying national technical standards is one of the main goals of the EC 92 consolidation program. Indeed, standards accounted for over half the areas outlined in the 1985 "White Paper on the EC Unification."[75] The EC has apparently decided that eliminating these technical trade barriers will allow European manufacturers to achieve significant scale economies in production, improving their international competitiveness.[76]

Many EC directives stipulate "essential" requirements needed to protect the health and safety of consumers and the environment. According to the concept of mutual recognition, if a product is certified by one member state as meeting these standards, it may be freely marketed in any EC nation. Member states must also accept each others' standards for nonessential requirements and for products for which no EC-wide regulations have been developed. On April 29, 1991, the EC Council of Ministers formally adopted a directive that establishes a harmonized approach to testing and certification of telecommunications terminal equipment, and provides for the mutual recognition of national laboratories' test results.[77]

Communications equipment exporters report two basic problems involving standards in the Japanese market. First, Japan's standards-setting procedures are often perceived as closed to outsiders, and second, the cost and time delays of complying with these standards are prohibitively high. Manufacturers outside Japan claim that the added expense of meeting Japanese standards is forcing them to forgo the Japanese market.[78] In 1981, the United States concluded a bilateral agreement with Japan to improve the chances of U.S. companies to gain a larger share of the Japanese market for communications equipment by making the standards-making process for such equipment more visible.[79] Although Japan adopted changes to implement this agreement in 1982, U.S. suppliers still complain of a lack of information and input into the process.[80]

The United States and Japan have been working to resolve these problems through negotiations. Many technical issues were clarified during the market-oriented, sector specific (MOSS) negotiations on telecommunications trade over the last few years. These negotiations led Japan's MPT to establish an impartial system for approving communications terminal equipment. Such approval is predicated on MPT accepting manufacturer-generated test data to verify that equipment meets Japanese standards, which merely require that such equipment pose no harm to the network and cause no degradation in the performance of network equipment.[81]

Despite the MOSS negotiations, standards and MPT approval have continued to be important issues in recent U.S.-Japanese disputes on communications.[82] For example, in 1989, as a part of a 1989 review mandated by Section 1377 of the Omnibus Trade and Competitiveness Act of 1988, the United States Trade Representative determined that U.S. access to Japan's market for third-party radio frequency communications equipment was being limited by a host of barriers that violated several elements of the MOSS agreements concluded in 1986.[83] Behind the determination was a 1987 decision by MPT to only allow one competitor to Japan's major carrier, NTT, in each of Japan's two major cellular regions, and a decision by the designated carrier in the important Tokyo region to purchase only equipment conforming to NTT standards.

In addition, a major U.S. producer and service provider, Motorola, complained that MPT's third-party radio-licensing and approval systems discriminated against the firm by requiring it to undergo more onerous licensing procedures than those applied to domestic firms.[84] Although, a resolution of both issues was finally reached on June 28, 1989, continuing difficulties in other areas have led U.S. trade officials to hold regular MOSS oversight meetings with the Japanese Government to resolve outstanding issues related to standards, testing, approval, and access to Japan's communications equipment market.

Procurement Policies

The public communications service providers are the main purchasers of communications equipment and, in most countries, are also government owned or controlled monopolies. Although procurement policies among telecommunications authorities vary, most operate in a manner which puts domestic suppliers in a preferred position. This preference stems, at least in part, from using TA's procurement to achieve political and economic goals. By favoring domestic suppliers, TA procurement supports technological, employment, and social goals.

---

[74] Michael Calingaert, *The 1992 Challenge from Europe*, The National Planning Association, Washington DC, 1988, p. 26, and *Europe Without Frontiers: Completing the Internal Market*, Commission of the European Communities, February, 1988, p. 14, cited in *The Effects of Greater Economic Integration*, USITC publication 2204, July 1989 pp. 6-9.

[75] Ibid., pp. 6-7.

[76] USITC, *Effects of Greater Economic Integration*, USITC publication 2318, September 1990, pp. 4-8.

[77] EC Council, Directive 91/263/ECC, *OJ*, No. L 128 (May 23, 1991).

[78] U.S. industry officials, interviews by USITC staff in Washington, DC, March 1991.

[79] U.S. General Accounting Office, *U.S. Japan Trade: Evaluation of the Market-Oriented Sector Selective Talks*, Report to the Honorable Lloyd Bentsen, U.S. Senate, GAO/NSIAD-88-205, Washington, DC, July 18, 1988.

[80] USTR, Report on National Trade Estimates.

[81] Ibid.

[82] USITC, *Operation of the Trade Agreements Program 41st Report, 1989*, USITC publication 2317, September 1990, p. 107.

[83] Ibid., p. 106.

[84] Ibid., p. 107.

The procurement policies of government-owned and private communication services providers are based on different imperatives. Private providers are more influenced by the need to increase profits than are government-owned providers. Thus, private providers are more concerned with cutting costs and improving services.[85] As a result, these markets for communications equipment are relatively open to domestic and foreign suppliers because equipment purchases are neither government directed nor related party transactions. The exception to this would be a service provider with a captive equipment supplier.

Public procurement by European telecommunications authorities is governed by the EC directive on public procurement, formally adopted by the EC Council of Ministers in 1990.[86] The directive is binding on all public and private entities that provide basic telecommunications services on an exclusive, or monopoly, basis and governs procurement of network and terminal equipment, switching software, and equipment installation and service contracts.[87] For communications equipment contracts over ECU 600,000, the directive also stipulates that EC bids[88] may be selected over lower non-EC bids as long as the EC bid is less than 3 percent higher than non-EC bid. In addition, any bid can be rejected if the total value of the system, both equipment and software, has less than 50 percent EC content. Many U.S. companies are opposed to the inclusion of the value of telecommunication software for the purposes of determining whether a bid is of EC origin because 60 to 80 percent of all switching equipment costs come from software development done in the United States.[89] The directive allows adjustment of the treatment of non-EC bids through bilateral or multilateral negotiations that ensure EC access to foreign markets.[90]

The United States and the EC are currently discussing a far reaching expansion of the coverage of the GATT government procurement code, which would be broadened to include utilities, public works, and services. The EC has expressed willingness to have its telecommunications authorities included in the utilities covered under the code, provided that the United States agrees to include U.S. communications service providers under the code. Even though they are not government controlled entities, British Telecom and Mercury Communications have agreed to be governed by the terms of this proposal. The United States objects to the EC proposal on the grounds that communications service providers in the United States are private companies, and as such, the Government has no control over their procurement policies. In response, the EC argues that because monopoly service providers have been granted market concessions by the government, they should be required to abide by certain procurement rules. Until these differences are resolved through negotiations, the EC directive will govern all TA procurement in the member states.

For many years, procurement by Japan's NTT was confined almost exclusively to domestic manufacturers NEC, Fujitsu, Hitachi, and OKI. In 1981, the U.S. Government implemented a bilateral agreement with Japan, in which the government-owned NTT agreed to allow some foreign communications equipment suppliers to bid on certain procurements.[91] However, despite this and several follow-up agreements over the next few years, U.S. negotiators remained dissatisfied with the extent to which NTT had increased its purchases of foreign-made equipment. Although total foreign procurement by NTT rose from ¥4.4 billion in 1981 to ¥50.4 billion in 1989, it represented less than 5 percent of total procurement.[92]

When Japan announced it would privatize NTT and restructure its communications industry in 1985, U.S. officials were concerned that language in the proposed legislation would strictly control Japan's market and limit foreign access.[93] As a result, such issues were given prominent attention in the 1985 MOSS talks between the United States and Japan.[94] In 1989, Japan and the United States renewed the bilateral agreement on NTT procurement for 3 years ending in December 1992.[95]

---

[85] Charles R. Lee, "Highlights from President's Report at Annual Meeting," GTE Shareholders News 1991 First-Quarter Report, p. 9.

[86] EC Council, Directive 90/531, *OJ*, No. L 297 (September 17, 1990). The directive also covers the transport, electricity, and water utilities sectors.

[87] The directive will become effective Jan. 1, 1993 for all EC member states except Spain (which has until June 1, 1996) and Portugal and Greece (which have until January 1, 1998).

[88] The origin of a bid is determined by comparing the total value of the component products that are of EC origin with the total value of non-EC origin components. The origin of each component of the bid is determined by the last substantial transformation rule. Software used in telecommunications equipment is considered a manufactured product and contributes to the determination of origin.

[89] Representative of the U.S. telecommunication equipment industry, interview by USITC staff, Washington, DC, June 1991.

[90] USITC, *Effects of Greater Economic Integration*, USITC publication 2318, September 1990, pp. 6-5.

[91] U.S. General Accounting Office, *U.S. Japan Trade: Evaluation of the Market-Oriented Sector-Selective Talks*, Report to the Honorable Lloyd Bentsen, U.S. Senate, GAO/NSIAD-88-205, Washington, DC, July 18, 1988.

[92] NTT News Release, Apr. 10, 1991. NTT's foreign procurement measured in U.S. dollars was $352 million in 1989 and USITC, *Operation of the Trade Agreement Program, 41st Report, 1989*, USITC publication 2317, September 1990, p. 107.

[93] Ibid.

[94] For background on the MOSS talks see USITC, *Operation of the Trade Agreements Program, 37th Report, 1985*, USITC publication 1871, September 1986 p. 159.

[95] Under the terms of the pact, Japan agreed to place part of NTT procurement under the Government Procurement code and to conduct other NTT procurement practices in conformance with code obligations. NTT also agreed to a services of measures that increase access to the Japanese interconnect market. USITC, *Operation of the Trade Agreements Program, 41st Report, 1989*, USITC publication 2317, September 1990 p. 107 and USITC, *Operation of the Trade Agreements Program, 32nd Report, 1980*, USITC publication 1307, 1982, p. 66.

Although Japanese imports of communications equipment have risen over the past several years, some U.S. industry officials have pointed out that the increases were from a very small base and have not been commensurate with growth in the Japanese communications market itself. Therefore, most industry officials support continued bilateral negotiations with Japan over procurement issues.

Export Controls

The U.S. Regime

Since World War II, the United States has continuously maintained a system of strategic export controls. U.S. export controls are generally imposed to restrict exports of goods and technology that would make a significant contribution to the military potential of the Soviet Bloc or the People's Republic of China. The United States controls the exports of such goods and technology under the Export Administration Act of 1979 (EAA), as amended, for national security and foreign policy reasons. The United States also seeks to control reexports of U.S. goods, as well as exports of foreign goods by U.S. subsidiaries abroad and export of foreign goods that incorporate U.S. components or technology. These restrictions may limit U.S. exports of components because the foreign purchaser does not want to be subject to U.S. export control regulations that would restrict sales of the finished product.

The EAA authorizes licensing requirements for exports of dual-use goods and technical data. Dual-use goods are those that may have military as well as commercial use. The EAA provides that the Secretary of Commerce may require a general license, a validated license, or any other type of license that may assist in the effective and efficient implementation of export controls. A general license permits exports without application by the exporter to the Department of Commerce (DOC). Exporters of goods that do not qualify for a general license must apply for a validated license. Consistent with the strategic policy of export controls, license requirements depend on the nature of the good and the country of destination. U.S. export controls also apply to reexports of U.S. goods and technology.[96]

The Export Administration Regulations (EARs) implement the EAA.[97] The EARs contain the Commodity Control List (CCL), which describes all commodities subject to control by DOC.[98] The EARs provide that, with certain exceptions, exports from the United States of all commodities and all technical data are prohibited unless and until a general license authorizing such export is established or a validated license or other authorization is granted.[99] In periodically reviewing the scope of the CCL, DOC considers such matters as a commodity's essential physical and technical characteristics, its civilian and military uses, its end-use pattern in the United States, its availability abroad, and whether it is the latest, state-of-the-art technology.[100]

Multilateral Controls

Multilateral agreements seek to ensure that allies maintain comparable export controls and that controlled articles are not reexported to controlled destinations. The multilateral export control regime is administered through the Coordinating Committee on Multilateral Export Controls (COCOM). The United States participates in the work of COCOM which administers control lists on munitions, nuclear energy, and dual-use technologies. COCOM imposes various levels of controls, ranging from a strict "general embargo" control, which requires unanimous COCOM approval, to a flexible "national discretion" control, which only requires post-export notification, depending on the good's level of technology and the country of destination. COCOM controls are set forth in the so-called Industrial List.

COCOM operates on the basis of unanimous consent of its member nations, but actual implementation of the controls rests with individual members. Accordingly, varying practices have evolved, and members interpret, administer, and enforce the multilateral export controls differently. For example, unlike its trading partners, the United States has even required licenses for exports to other COCOM countries. The United States has consistently imposed additional controls unilaterally. In the early years, unilateral U.S. controls tended to be effective because the United States was often the sole source of a great deal of high-technology equipment. In more recent years, sophisticated, high-technology equipment has been available from a variety of COCOM and non-COCOM sources, thus making unilateral controls less effective.

The stringency of the U.S. export-control regime has reportedly created significant problems for the U.S. communications equipment manufacturers.[101] In some cases, export sales have been lost due to the cumbersome approval process, even when the prospective sale is to a COCOM member, or because an export license is not granted at all. For example, U.S. and British participation in a Soviet trans-Siberian fiber optic cable project was precluded by COCOM restrictions as is communications technology transfer in Eastern Europe. As a result, the Soviet Union began negotiations with Korea, which may be able to supply the necessary equipment, and Ericsson, which is not a member of COCOM, is free to provide the training and know-how required to sell in Eastern European markets.

[96] 15 CFR 774.1.
[97] 15 CFR 768 *et. seq.*
[98] 15 CFR 799.1 *et. seq.*
[99] 15 CFR 770.3(a).
[100] 15 CFR 770.1(b)(3).
[101] Industry representatives (NATA/TIA/IDCMA), conversation with USITC staff, Nov. 19, 1990.

In addition, many U.S. companies have had problems getting foreign partners to form business consortiums because of the lengthy delays in getting an export license approved. Communications industry officials indicate that even though DOC is ostensibly responsible for the administration of export control laws, State Department, Defense Department, and National Security Agency oversight over the official DOC review process adds months and, sometimes, even years to the approval process. In other COCOM countries such as Japan, where such controls are managed by MITI rather than the military, the turnaround time for the approval process is 2 to 3 days.[102]

Export Incentives

Many governments offer industry incentives to encourage and promote exports. These incentives include concessionary financing, tax breaks, tied aid, and export credits. Figures 4-6 and 4-7 at the end of this section list examples identified by the U.S. Export-Import Bank (Eximbank) of sales lost and won by U.S. firms because of tied-aid arrangements. In some countries, the use of export incentives is an outgrowth of strategically targeting certain industries to be export leaders. The U.S. Government does not participate in these types of incentives to the extent that its major competitors do. The communications equipment industry has argued that foreign firms have greater access to subsidized credit for foreign sales, whereas Eximbank has only $0.5 billion available for credit for overseas sales for an industry in a $100 billion market.[103]

One advantage that various industry officials attribute to Japanese companies is their ability to offer attractive financing.[104] Much of the current and future demand for communications systems is expected to come from newly industrialized countries and some less developed countries. The ability to offer flexible financing may significantly affect the U.S. industry's ability to win contracts in these countries. Japan often conditions its large loans and grants to developing countries with procurement of Japanese equipment and technology, a practice known as tied aid. This is an approach that some believe "not only enriches Japanese firms in the short run, but also provides them with a strong marketing edge once an aid program is finished."[105]

> The vast majority of Japan's aid comes as low interest rate, or "soft," loans for big infrastructure projects such as power stations, telecommunications systems, and energy and transport, and the Japanese loans have strings attached; U.S. and European companies are largely excluded from participation in the projects, permitting Japanese firms to make immediate profits, establish their technologies in nascent industries and develop future markets.[106]

In other cases, Japan has offered soft loans or grants for project feasibility studies that are then awarded to Japanese firms. Although the loans and the awards are technically independent and bidding is open to all, the fact that many of the specifications were written by Japanese firms gives Japanese bidders an advantage. A recent Eximbank study found that U.S. firms were often at a disadvantage and lost sales because of a lack of concessionary financing.[107] The study details how a U.S. digital switch manufacturer lost a $17.5 million sale to a European firm due to its inability to offer a mixed credit package to the customer. Concessionary financing is credited in part for the control exercised by a Canadian company over the satellite earth station market in China. In fact, U.S. companies have often had to source equipment from non-U.S. facilities or foreign affiliates in order to access the mixed credit support deemed necessary to win the contract.[108]

Some U.S. economists and industry officials have recommended that the U.S. Government should do more to integrate the specific needs of U.S. businesses into its foreign aid budget, particularly in areas of the world where markets are young and Japanese and Europeans work aggressively. In response, U.S. embassies were recently provided with instructions to integrate more closely the activities of DOC and the Agency for International Development (AID), which administers U.S. aid to developing countries.[109] In 1987, AID established a 3-year, $300 million "war chest" to help U.S. firms arrange competitive soft loan financing against Japanese and European firms.[110] However, the amount available to U.S. firms for such loans was, reportedly, much smaller than that made available to foreign competitors by their governments.[111] In 1987, long term official export credits for all OECD countries were $12.7 billion and the U.S. total for that year was only $700 million.[112]

---

[102] Teddi C. Laurin, "Straightening Out Export Controls," *Photonics Spectra*, October 1990, p. 5.

[103] Industry representatives (NATA/TIA/IDCMA), conversation with USTIC staff, on Nov. 19, 1990.

[104] USITC, *U.S. Global Competitiveness: Optical Fibers*, USITC publication 2054, p. 11-7.

[105] Steve Coll, "Japan's Hands-On Foreign Aid," *Washington Post*, Jan. 13, 1991, p. H1 and H4.

[106] Ibid.

[107] Export-Import Bank of the United States, *Report to the U.S. Congress on Tied Aid Credit Practices*, pp. 185-220.

[108] U.S. Department of Commerce, *U.S. Telecommunications in a Global Economy: Competitiveness at a Crossroads*, August 1990, p. 101.

[109] Steve Coll, p. H4.

[110] Export-Import Bank of the United States, *Report to the U.S. Congress on Tied Aid Credit Practices*, pp. 23.

[111] Ibid., p. 25.

[112] Ernest H. Preeg, *The Tied Aid Credit Issue: U.S. Export Competitiveness in Developing Countries* Washington, DC: The Center fro Strategic and International Studies, 1989, p. 13.

Figure 4-6
Communications Equipment Sales Won by American Companies Due to Tied Aid Credit

Product	Purchaser & Year	US Contract Value (Potential Follow-on)	Foreign Competition	Eximbank Tied Aid Package
Domestic Satellite Network	Gabon 1986	$21 million ($7 million)	Alcatel	5.48% interest, 30 year term
Satellite Communications Equipment	Indonesia 1987	$17 million ($5-15 million)	NEC, Spar	Concessionary credit
Domestic Satellite System	Algeria 1987	$17.3 million ($5-10 million)	NEC	Matched offer from NEC
Cellular Radiotelephone System	Gabon 1987	$8.5 million ($10 million)	CSF Thomson, Matra	5.34% blended rate
Cellular Radiotelephone Instruments & System Expansion	Thailand 1987	$11.6 million ($20 million)	Mitsubishi, Ericsson	Line of credit and grant with effective rate of 4% on 20 year term

Source: Export-Import Bank of the United States, *Report to the U.S. Congress on Tied Aid Credit Practices*, April 1989.

Figure 4-7
Lost Communications Equipment Sales* by American Companies Due to Tied Aid Credit

Product	Purchaser & Year	US Contract Value (Potential Follow-on)	Winning Competitor	Tied Aid Source and Details (if known)
Digital Switching Equipment	China 1987	$17.5 million ($15 million)	ITT-Alcatel	Spain: Grant for 35% of the contract cost
Analog Switching and Ancillaries	Indonesia 1985/86	$10 million ($4 million)	Phillips	Netherlands
Digital Switching Equipment	Jordan 1985	$100 million ($10 million)	NEC	Japan
Submarine Cable System	Indonesia 1988	$65 million	NEC	Japan
Microwave Transmission System	Egypt 1985	$40 million	Telettra	Italy
Submarine Cable System	Malaysia 1988	$80 million	STC	United Kingdom: 100% loan in local currency
Satellite Earth Stations with Microwave Links	Mexico 1986	$21 million ($10 million)	NEC $12 million of contrac	Japan
Cellular Communications Systems	China 1986	$8 million ($80 million)	Ericsson	Sweden
Cellular Communications and Other Equipment	Jamaica 1988	$3.7 million ($10 million)	NEC	Japan: 4.5% interest, 5 year grace period, 40 year repayment

* Lost Sales include cases in which "the U.S. exporter clearly would have won the order or contract had tied aid credit financing not been present," according to the professional judgement of the Eximbank Engineering staff.

Source: Export-Import Bank of the United States, *Report to the U.S. Congress on Tied Aid Credit Practices*, April 1989.

Although targeted industrial policies include measures, such as R&D funding and procurement policy, that are sometimes not directly related to export promotion, many result in growth in the export potential of the targeted industries. The targeted industries are often high technology industries, including the communications equipment industry. The Governments of many European nations, Japan, Korea, and Taiwan have all actively promoted high technology industries. Industrial policy initiatives of the European Community in the communications sector, however, have been resisted by many member states. Nationalism and differing economic philosophies and levels of development have made coordination difficult. In contrast, Japanese policy is characterized by government, labor, and industry consensus. The United States has never had a Federal policy to promote the communications sector and is unlikely to, given its tradition of and support for free-market policies.[113]

Other Support and Incentives

A number of industry experts assert that certain global communications equipment manufacturers benefit more than others from well-focused government policies to promote the development of advanced-technology industries.[114] Much debate on the issue of industrial policies in the United States and Europe has arisen in recent years, as many attribute much of Japan's success in advanced-technology areas, such as electronics and communications, to industrial policies by the Japanese Government in the postwar era.[115]

Japan

Many industry analysts believe that Japan's major electronics and communications equipment manufacturers benefited significantly from past Japanese government policies, coordinated by the Ministry of International Trade and Industry (MITI), to promote high-technology industries.[116] Examples of such policies included special financing for research and development, relaxed antitrust regulations, low-interest loans, and tax incentives. However, in recent years, many of MITI's formal powers over industry have lapsed.[117]

MITI's prominent function has been transformed more into a signaling and coordinating role for advanced-technology industries, rather than providing substantial financial support.[118] Through high-visibility government studies; joint industry, academic, and government committees; highly publicized campaigns; and cooperative research projects that call attention to emerging technologies, MITI has tried to motivate and influence the direction of innovation and change in companies.[119] It has also tried to channel its limited resources into more high-risk, high-gain projects to promote advanced technologies, intended to complement rather than replace corporate R&D. In several national projects, jointly supported by MITI, NTT, Japan's Ministry of Posts and Telecommunications, and major Japanese communications equipment producers, Japan has focused on fiber optics, optoelectronics, and advanced communications networks as the foundation of its 21st-century economy.[120] MITI forecasts that by the year 2020, the fiber network will generate service revenues and provide the transport infrastructure for up to one-third of Japan's GNP.[121] Japanese industry officials believe that the real importance of their government's support for development of particular technologies or industries is not the direct financial support received from the government but the fact that the focused attention on the industry enables it to more readily attract financing and other needs from private capital markets.[122]

Europe

Some European governments have also targeted industries to compete in global markets.[123] One example is French government support of industries, such as aerospace, automobiles, electronics, and communications.[124] France has a government-driven industrial policy that supports industries with export financing, R&D assistance, and restrictions that close the French market to imports.[125] Some experts also believe that very close relationships developed between French government and industrial leaders in an elite educational system have led to a greater propensity for government-industry cooperation in the past. Nevertheless, other analysts believe that French policies and subsidies in the early 1980s to establish France as a technological leader in computer and communications industries were failures, resulting in large corporate deficits and layoffs of French workers in 1984 and 1985.[126]

---

[113] U.S. Department of Commerce, *U.S. Telecommunications*, August 1990, p. 98-99.

[114] Industry and government officials and analysts, interviewed by USITC staff, in the United States, Europe, and Asia, March-May 1991.

[115] Peter F. Cowhey, "Telecommunications," *Europe 1992: An American Perspective*, p. 159.

[116] Michael E. Porter, *The Competitive Advantage of Nations*, New York, NY: The Free Press, 1990, p. 416.

[117] Ibid.

[118] U.S. and Japanese industry and government officials, interviewed by USITC staff, in Tokyo, April 1991.

[119] Porter, *The Competitive Advantage of Nations*, p. 415.

[120] George Gilder, "Into the Telecosm," *Harvard Business Review*, Mar.-Apr. 1991, p. 158.

[121] Ibid.

[122] Japanese industry officials, interviewed by USITC staff, in Tokyo, April 1991.

[123] Cowhey, "Telecommunications," p. 159.

[124] U.S. communication equipment company officials, interviewed by USITC staff, in Europe, April 1991.

[125] Industry and government officials, interviewed by USITC staff, in France, April 1991.

[126] Eli M. Noam, "International Telecommunications in Transition," *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, pp. 281-287.

In general, however, policies in various other European countries to help firms develop and compete in advanced-technology areas, such as communications, are not as well coordinated as in France and Japan. The EC has been more active than most member state governments in recent years in encouraging establishment of programs to coordinate various advanced-technology endeavors.[127] Several programs have been initiated in the past few years to promote joint research and development by industry, government, and university scientists and technologists in advanced communications.

The most generously funded of the EC programs, RACE, was launched in 1985, with the objective of establishing a pan-European integrated broadband communications network within 10 years. ESPRIT, another important EC program directed at smaller and medium sized firms, is a 10-year program to provide the European communications and information technology industry with technology to remain competitive in international markets over the next decade.

United States

In the United States, industrial policies for promoting specific industries have traditionally been discouraged by leading politicians. Specific support for industries has largely been limited to large-scale defense projects, such as the Strategic Defense Initiative or work conducted in military facilities, such as the Naval Research Laboratories, little of which is transferred to private companies for commercial purposes.[128]

However, in the past several years, Congress has established several programs to provide support to advanced-technology projects sponsored by industry and universities. The National Institute of Standards and Technology was allocated $35 million in 1991 to fund grants to develop promising new technologies and an additional $11.9 million was provided to support five manufacturing centers to help small and medium-sized companies learn the techniques of automated production.[129] The National Science Foundation recently provided the Center for Telecommunications Research at Columbia University a $14.3 million grant for work to increase fiber optic capacity.

Critics of recent U.S. efforts to promote industrial development say that funding is too low compared with efforts in Japan and the EC and grants are awarded on an ad hoc basis with little coordination in key technologies, such as communications.[130] They say the U.S. approach has been less coordinated than the Japanese or EC programs, providing small amounts of funding to many different and unrelated high-technology ventures.[131] The critics also point out that U.S. firms have been less willing than foreign firms to work together on research and development. Others believe, however, that less centralized government involvement in U.S. markets has led to greater innovation and entrepreneurship in the U.S. communications equipment industry.

Summary

The most important government policies affecting the communications equipment industry are regulation, trade, and antitrust. Regulation of the communications service provider has shaped the structure of the equipment industry, controlled market access, and influenced technology. These policies represent attempts to promote political, economic, and social goals, such as universal service, employment, and education. Some manufacturers of communications equipment have benefited from government procurement and standards policies that protected home markets from competition while helping them export to foreign markets. Government procurement policies have helped build and sustain the embedded base held by national suppliers by giving preference to companies that manufacture equipment in that country.

Government-supported policies can also have a significant impact on trade in the communications industry. Policies that determine the standards-setting, testing, and certification processes can act as nontariff trade barriers. In addition, government incentives to the industry, including concessionary financing, tax credits, tied aid, and export credits promote export growth. Some countries, such as Japan and France, use these incentives to strategically target certain industries. The United States, however, does not offer these incentives to the same extent as other countries.

Until recently, the United States was the only major country that actively applied antitrust laws to the communications industry. Communications services in most countries involved only basic telephone services and were provided by government owned or controlled entities; as such, they tended not to be subject to antitrust laws. Equipment manufacturers tended to be privately owned and unrelated to service providers. However, this situation is currently changing as more countries liberalize their communications market and allow new entrants to offer new services and, in some instances, to compete to provide traditional services. In line with this trend, many countries are now scrutinizing competitive conditions in their national markets more carefully.

---

[127] Cowhey, "Telecommunications," p. 159.

[128] John Housha, "An Industrial Policy, Piece by Piece," *The New York Times*, July 30, 1991, p. D1.

[129] Ibid.

[130] U.S. industry officials, interviewed by USITC staff, March 1991.

[131] Government and industry officials, interviewed by USITC staff in the United States, Asia, and Europe, March-May 1991.

CHAPTER 5
COMPARATIVE REGIONAL ANALYSIS

Introduction

The importance of foreign markets is expected to increase for the communications equipment industry. The high cost of developing sophisticated switching software and advanced communications technologies can no longer be supported solely by sales in any one market, except, perhaps, the largest. Therefore, producers will have to increase their sales base to include foreign markets in order to succeed in the future.

A number of determinants affect the success and competitiveness of communications equipment suppliers in global markets. Some of these factors, such as research and development expenditures, advanced manufacturing techniques, and effective foreign marketing strategies, are within the control of firms. However, other factors are external to firms, and thus are less within their control. These factors are government regulation, procurement policies, embedded equipment base, and various trade policies that may help or hinder the competitiveness of a nation's firms.

The following sections present a comparison of how some of these factors have affected the relative competitiveness of communications equipment producers in North America, Europe, and Asia. Major manufacturers from each of these areas have their own strengths and weaknesses and have benefited differently from some of the critical determinants affecting the industry. Some of these differences are highlighted in this evaluation.

Internal Factors

Technology

North America

From the initial Bell patents on the telephone at the end of the last century and the establishment of Bell Laboratories in this century, AT&T dominated communications technology.[1] Technology that was not created in house was acquired by licensing or purchasing, such as when AT&T bought the patent rights to the loading coil, shortly after the initial telephone patents expired in 1893.

Partly as a result of this legacy, U.S. communications equipment manufacturers continue to be among the most technologically advanced firms in the world. Though challenged by foreign competitors, U.S. firms, like AT&T, continue to develop advanced communications switching systems. As software increases in importance in such systems, a commanding U.S. lead in software development gives U.S. equipment producers a significant competitive edge. U.S. firms are also global leaders in production technology for new transmission systems; AT&T and Corning Glassworks developed and maintain a dominant technological lead in the manufacture of optical fiber and Motorola has established itself as a leading innovator of cellular telephones and network equipment.

However, a number of factors have gradually eroded the technological dominance of the U.S. industry. The rapid and uncontrolled pace of technology, partially engendered by Bell Labs discoveries in microelectronic and digital technology, led to rapid diffusion of basic electronics technologies in the decades following World War II.[2] A direct result of U.S. Government concern about antitrust was the diffusion of U.S. technology mandated by the Justice Department's 1956 consent decree with AT&T, which required the company to license patents to other firms.[3] Such technological diffusion enabled other firms, including foreign manufacturers, to narrow the technological gap and even advance ahead of U.S. firms in some areas.

Development efforts of Canada's Northern Telecom enabled it to technologically "leapfrog" AT&T when it introduced the first digital central office switches in North America.[4] This advance resulted from both a diffusion of AT&T's basic digital technology and AT&T's historic reluctance to prematurely introduce new products into the network before old equipment had reached the end of its economic life.[5] This technology was principally responsible for establishing Northern Telecom as a major competitor in the United States and in other foreign markets. Northern Telecom's research efforts have also enabled the company to develop other advanced communications products, including fiber optic transmission equipment, mobile and cellular technology, PBXs, and advanced feature telephone systems.

Europe

In Europe, French-based Alcatel has been a leading innovator of advanced digital switching systems. Meanwhile, the United Kingdom is a leading source of software expertise. Technological advances by Sweden's Ericsson in cellular telephones and

[1] Gerald R. Faulhaber, *Telecommunications in Turmoil: Technology and Public Policy*, Cambridge, MA: Ballinger Publishing Co., 1987; and John Brooks, *Telephone: The First Hundred Years*, New York, NY: Harper and Row, 1975.

[2] Faulhaber, pp. 33 and 34.

[3] Ibid.; and Brooks. This requirement was rescinded under the terms of the 1982 Modification of Final Judgement.

[4] Jerry A. Hausman and Elon Kohlberg, "The Future Evolution of the Central Office Switch Industry," ch. in *Future Competition in Telecommunications*, Cambridge, MA: Harvard University, 1989.

[5] Faulhaber, pp. 33 and 34.

networks makes it a leading challenger to U.S.-based Motorola in world markets. German firms such as Siemens have contributed to the development of reliable electronic communications components and transmission systems.

However, despite European success, some industry analysts have pointed to certain problems of European companies in adapting their technology to foreign markets.[6] For example, the European switch developed by ITT and inherited by Alcatel when it acquired much of that company's communications business has not proven to be adaptable to the important U.S. market. This failure has occurred despite substantial French Government funding of digital technology. European companies have also had difficulty providing many of the sophisticated features required by RHCs and larger independent phone companies in the United States, limiting their opportunities to rural exchanges or cellular niche markets.

Japan

Although Japanese firms lag behind U.S. and certain European firms in advanced switching technology and software development, technological advantages in other areas permit them to challenge U.S. and European firms in global markets. The major Japanese firms were among the leading beneficiaries of the diffusion of basic transistor and microelectronics technologies initially developed in U.S. laboratories, such as Bell Labs. NEC, Fujitsu, and Hitachi are now among the leading producers of electronics technology in the world. Many achievements by Japanese firms in electronics have been translated into strengths in advanced communications systems. For example, Japanese firms have developed advanced optoelectronics technologies, enabling them to become leading producers of electronic devices such as facsimile machines and lasers that transmit voice, video, and data through optical fiber systems.

Firm Structure

Many industry observers believe that structural differences among major communications equipment manufacturers in North America, Europe, and Japan influence their competitiveness in international markets. The three largest Japanese firms, for example, are highly integrated electronics producers that have diversified into communications equipment as well as computers. The major German producer, Siemens, also has historically been a major electronics producer, as well as a manufacturer of communications equipment.

Although the French giant Alcatel is focused on communications equipment, it was formed by the French electrical conglomerate CGE[7], and has incorporated remnants of the communications unit of the French electronics firm Thomson into its own business. The two major North American producers, meanwhile, have historically focused almost solely on communications equipment. For Northern Telecom, such a focus has been largely by choice, but for AT&T, regulatory and antitrust decisions required it to limit its activities to communications services and equipment for much of its history.

Japan

A number of industry experts believe that the large-scale, broadly diversified structure of the major Japanese producers has enabled these firms to gain economies of scale and scope in manufacturing and marketing a wide variety of communications, computer, and electronic products.[8] Economies of scale provide larger Japanese companies with cost advantages in mass producing products for domestic and foreign consumption. Economies of scope permit companies to spread research and development, marketing, and manufacturing costs over a broad range of diverse electronics products which depend on similar inputs, such as electronic components and circuit boards.[9] Japanese industry officials believe that diversity and integration also permits them to control the supply of critical components required in advanced communications and computer systems.[10]

The major Japanese producers are each members of larger industrial and trading groups known as keiretsu, which are relatively loose groupings of firms horizontally connected with one another through cross shareholdings.[11] The most notable of the horizontal keiretsu were derived from much more-tightly organized pre-World War II industrial combines called zaibatsu. At the center of each group is a major bank. Four major groups dominate the communications sector—Sumitomo (NEC and affiliates), Dai-ichi Kangyo (Fujitsu), Fuji (OKI and affiliates), and Hitachi.

A number of analysts assert that firms belonging to major Japanese keiretsu represent guaranteed markets for one another and that ties among the companies lead to market dominance and cartelization.[12] The analysts point out that since bank loans are a major source of

[6] Industry officials in Germany and France, interviews by USITC staff, April 1991.

[7] Compagnie Generale d'Electricite.

[8] Japanese industry and government officials, interviews by USITC staff, Tokyo, April 1991.

[9] David Charles, Peter Monk, and Ed Sciberras, *Technology and Competition in the International Telecommunications Industry* (London: Pinter Publishers Ltd.), 1989.

[10] Officials of several major Japanese producers of electronic and communications equipment, interviewed by USITC staff, Tokyo, April 1991.

[11] Robert Z. Lawrence, "Efficient or Exclusionist? The Import Behavior of Japanese Corporate Groups," *Brookings Papers on Economic Activity*, edited by William C. Brainard and George L. Perry, (Washington, DC: Brookings Institution, 1991), pp. 311-330.

[12] Michael E. Porter, *The Competitive Advantage of Nations* (New York, NY: The Free Press, 1990), pp. 153 and 154.

capital for Japanese companies, the banks can exert a substantial degree of control over the group as a whole by influencing strategic and tactical decisions of member firms.

Although other scholars warn of the danger in overestimating the strengths of keiretsu relationships of Japanese firms, most industry observers agree that the special relationships developed among members of a keiretsu provide synergistic benefits and diversification to firms that cooperate on technological development and send signals to one another about market needs.[13] For example, two members of the Sumitomo Group, NEC and Sumitomo Cable, have worked together for many years in developing fiber optics technology, with NEC specializing in lasers, detectors and other electronic components, and Sumitomo Cable in optical fiber and cable.

Each of the major Japanese producers of communications equipment is also involved in subcontracting and supplier relationships (or vertical keiretsu) with a number of secondary and tertiary producers of a broad array of associated equipment, components, and parts utilized in communications networks and systems.[14] Although the major Japanese producers often maintain a relatively small financial interest in their subcontractors and suppliers, they are able to influence the suppliers by providing them with access to their market and their technology. As a result, many of the suppliers are well integrated into the larger corporations' total production systems.

Although Japanese producers do not appear to benefit to as large an extent as European firms, such as Siemens and Alcatel, from large-scale global operations, the internationalization of the two largest Japanese firms has been increasing rapidly over the past decade as governments in foreign countries have demanded communications systems suppliers to establish local factories and to contribute to the industrial development of their countries.[15] Fujitsu has manufacturing affiliates for communications equipment in 14 different countries in Asia, North America, Asia, Latin America, Australia, and New Zealand. Meanwhile, NEC has communications production or assembly facilities in 18 different countries in those areas as well as in Africa. Hitachi and OKI have much less developed overseas manufacturing networks for communications equipment.

North America

Although AT&T is a large-scale producer, benefiting from economies of scale in manufacturing, traditionally it has focused on manufacturing only communications equipment. In fact, prior to its breakup, AT&T was prohibited by the 1956 Consent Decree from producing equipment for purposes other than common carrier communications. Therefore, it has benefited less than Japanese producers from potential economies of scope.[16] Recognizing this weakness and freed by the Modification of Final Judgement (MFJ) from previous restrictions, AT&T has been pursuing expertise in other areas such as computers and office machines. The company originally attempted to enter these fields in the mid-1980s by acquiring 25 percent of Olivetti, an Italian firm. In the middle of 1991, AT&T acquired NCR, a leading U.S. computer supplier to banking and retail markets.

However, AT&T's vertical integration into manufacturing equipment and communications services is a structural advantage over many foreign firms. This integration gives AT&T experience in operating and maintaining a telecommunications network, in addition to designing and manufacturing equipment. Because few manufacturers operate networks, this is a rare competitive advantage. AT&T's integration also provides some degree of protection in its domestic market, since its equipment producing entity is guaranteed sales to the largest long distance service provider in the United States.

Although Northern Telecom does not operate its own network, its parent corporation Bell Enterprises does, as principal owner of Bell Canada. Thus this equipment manufacturer enjoys similar advantages to AT&T, i.e., having close relationships with a major service provider. A number of industry observers believe that the captive supply arrangement between Northern Telecom and Bell Canada provides Northern with possibly even greater protection in its home market than that enjoyed by AT&T. This is due to Bell Canada's continued dominance in both long distance and local communications services in Canada's largest Provinces.

Northern Telecom has consciously decided not to integrate computers into its product lines.[17] Many industry analysts believe that this strategy is appropriate for the company, since lack of experience would dilute its longstanding technical and marketing expertise if Northern Telecom pursued computers. AT&T's lack of success in establishing a computer capability has reportedly influenced Northern Telecom's decision to remain principally a communications equipment manufacturer.[18]

Motorola is not a full-line supplier of communications equipment but focuses instead on mobile communications and electronic components. Like the major Japanese equipment producers, Motorola is vertically integrated, as the firm produces semiconductors and other electronic devices that are

[13] Ibid.

[14] Japanese industry officials and analysts, interviewed by USITC staff, Tokyo, April 1991.

[15] Japan External Trade Organization, *Your Market in Japan* (Tokyo, Japan, March 1990), pp. 10 and 11.

[16] U.S. and Japanese industry officials, interviews by USITC staff in United States and Japan, March-May 1991.

[17] Industry officials in the United States and Japan, interviews by USITC staff, 1991.

[18] U.S. industry officials, interviews by USITC staff, March 1991.

essential components of the firm's two-way radios, cellular telephones, pagers, and supporting communications infrastructure equipment. Motorola also operates cellular systems throughout the world. The firm benefits from the reputation it has earned as a high quality, technological leader in all facets of radio communications.[19]

Europe

In the European communications equipment industry, no dominant type of firm structure exists. The range of products manufactured varies among major communications equipment firms. While Alcatel's main emphasis is communication equipment, which accounts for over 90 percent of sales, Siemens is more diversified, with approximately 30 percent of sales derived from communications equipment operations.[20]

Ericsson's main business is communications equipment, but it is not a full line producer like Siemens and Alcatel. Instead, it has concentrated on specialized markets, such as cellular radio equipment. In addition to product line differences, major European equipment producers are vertically integrated to different degrees. Siemens manufactures components for internal use, such as semiconductors and electromechanical components, and Alcatel and Ericsson purchase many components from outside sources throughout the world.

Since most telecommunications authorities favor national suppliers, major European communications equipment manufacturers have emphasized developing multinational corporate structures that permit a direct manufacturing and marketing presence in their most important markets.[21] Alcatel sells communications equipment in 110 countries and has manufacturing facilities in 22 countries. Likewise, Siemens has 210 production facilities throughout the world, including substantial investments in the United States and the United Kingdom.

Due to their multinational firm structures, major European communications equipment producers have developed close working relationships with various national telecommunication authorities in Europe and other important markets.[22] Having a local presence has enabled Alcatel, Siemens, and Ericsson to work closely with telecommunications authorities in product development and standards setting. These firms have also benefited from government procurement policies that prefer national suppliers and from government sponsored training programs.

European companies such as Siemens and Alcatel's parent CGE also had a long-term history of selling equipment such as electrical generation equipment to markets subject to government procurement. Some industry experts believe that such experience provided them with an advantage in selling in foreign markets for communications equipment, another area traditionally subject to government procurement. Meeting various telecommunications authorities' specifications and testing requirements for equipment may be less of a problem for European firms than for North American firms entering many markets because of their experience in these markets.

Manufacturing Techniques

Foreign manufacturers in Japan and Europe appear to have embraced advanced techniques to cut manufacturing costs more enthusiastically and for a longer period than North American firms.[23] Some experts point out that captive equipment supply arrangements unique to AT&T and Northern Telecom provided guaranteed markets for equipment and removed many incentives for cutting cost. However, Japanese and European firms, such as NEC, Fujitsu, and Siemens, have historically been involved in competitive markets for products other than communications equipment. This created incentives to develop manufacturing techniques to make products better and cheaper than their competitors.

Japanese electronics and communications equipment manufacturers have been among the most successful in implementing total automation strategies, particularly in the manufacture of advanced transmission and terminal equipment.[24] Producers in other Asian countries, such as Korea and Taiwan, are attempting to emulate Japanese success in this area. Total automation involves the systematic automation of as many manufacturing operations or tasks as is technically feasible, with consequent minimization of labor input into the manufacturing process.[25] Rising labor costs and labor shortages have especially stimulated increased automation by Japanese firms.

Although terminal products such as telephones, key systems, facsimile machines, and modems were viewed by major Japanese firms as the most suitable for totally automated manufacturing, the production of circuit boards and hardware for advanced transmission and switching gear has also been amenable to automation. For example, automated component-insertion technology has been increasingly used by large Japanese electronics and communications equipment producers for the preparation, assembly, and testing of circuit boards to be incorporated in advanced transmission and switching hardware.[26]

---

[19] Interviews with U.S. industry officials, during May 1991.

[20] Industry and government officials in France and Germany, interviews by USITC staff, April 1991.

[21] Ibid.

[22] Industry and government officials in Europe, interviews by USITC staff, April-May 1991.

[23] Industry and government officials and analysts, interviews by USITC staff, March-May 1991.

[24] Fumio Kodama, *Analyzing Japanese High Technologies: The Techno-Paradigm Shift* (London: Pinter Publishers, 1991).

[25] Charles, Monk, and Sciberras, p. 129.

[26] Japanese and Korean government and industry officials, interviews by USITC staff, April 1991.

All major Japanese producers of communications equipment have reported using computer-aided design (CAD) systems for both circuit design and drafting work and physical design of terminals.[27] These firms have also made use of some forms of computer-aided manufacturing (CAM) technology, especially programming of controls of automatic insertion and surface-mount technology machines and automated test equipment. In addition, they have increased efforts to integrate design, manufacturing, and testing functions through development of CAD/CAM systems. A longer term goal of Japanese manufacturers is computer-integrated manufacture (CIM). CIM is the automated coordination and control of the entire manufacturing process from product design through packaging and dispatching of finished goods.

Automation also plays a key role for all major European communications equipment manufacturers, with automation levels varying by product. The portion of product costs accounted for by production labor is very small compared with that for components, research and development, and software, and it is decreasing every year. By cutting costs and heavily automating manufacturing facilities, Alcatel has achieved productivity gains of 8 percent a year for the last 3 years.[28] Factory automation is also critical to Siemens, with productivity increases coming from new equipment investment. Typically, the whole manufacturing process is automated, with factory floor labor costs below 10 percent of product costs.[29]

U.S. manufacturers have placed less emphasis on automation. Industry officials indicate that for large network switching equipment in which firms such as AT&T excel, much of the value lies in software development and customized features not amenable to automation.[30] Furthermore, officials indicate that sales of such equipment depend on external factors, such as the availability of financing or tied government aid. Robotics is used less than in Japanese firms because U.S. industry officials believe it offers no substantial time saving over human labor.[31] Nevertheless, AT&T uses automatic insertion processes for developing circuit boards and in some processes involving transmission equipment.[32] However, the total automation and computer integration of manufacturing does not appear to be an overriding goal of U.S. manufacturers as it is for Japanese firms.

Firm Research & Development

North America

R&D spending varies by company and by product. The most sophisticated products, such as central office switches, require the highest investment in R&D. World-class manufacturers of switching equipment spend between 12 and 20 percent of switching revenues on R&D; manufacturers of low technology terminal equipment may spend less than 5 percent on product R&D.[33] The level of company R&D usually reflects its product mix. For example, AT&T's R&D expenditures for both services and equipment was nearly $2.7 billion in 1989, approximately 7.3 percent of sales.

AT&T has traditionally maintained a tremendous competitive advantage in communications technology due to its access to the results of research and development conducted by Bell Laboratories, one of the premier research facilities in the world.[34] For years, Bell Labs focused on very basic research, such as its fundamental work on transistors and microelectronics. It was also responsible for much of the initial development of lasers and optical fiber transmission systems. With the emergence of digital switching systems, AT&T has also focused considerable energies on developing sophisticated software.

However, with the divestiture of its Bell operating companies (BOCs), in accordance with the 1982 MFJ, AT&T lost a major source of funding for R&D. Prior to the divestiture, the BOCs were required to pay a licensing fee to AT&T, part of which went to support Bell Laboratories.[35] Some industry officials believe that the loss of this funding has limited the amount of basic research undertaken by AT&T in the past several years.[36]

The RHCs have now established their own research and development organization, Bell Communications Research (Bellcore). However, because the MFJ prohibits RHCs from manufacturing communications equipment, there is little incentive for them to allocate significant resources for new product development, since they cannot recapture expenses through product sales.[37] Thus, the divestiture may have led to a reduction in resources that might otherwise be available for the research and development of communications equipment in the United States.

Northern Telecom's consolidated expenditures on research and development amounted to over $808 million, or 13 percent of its total sales, in 1989. The major part of its research and development activities is conducted through its subsidiary Bell-Northern Research Ltd. (BNR), owned 70 percent by the corporation and 30 percent by Bell Canada. BNR operates laboratories in six Canadian locations and

---

[27] Charles, Monk, and Sciberras, p. 133.
[28] Company officials in Europe, interviews by USITC staff, April 1991.
[29] Ibid.
[30] U.S. Industry officials, interviews by USITC staff, March 1991.
[31] Ibid.
[32] Ibid.
[33] U.S., European, and Japanese industry officials, interviews by USITC staff, March-May 1991.
[34] Faulhaber, pp. 9 and 33.
[35] Crandall, p. 149.
[36] Industry officials, interviews by USITC staff, November 1990.
[37] Robert G. Harris, "Divestiture and Regulatory Policies," *Telecommunications Policy*, April 1990, pp. 110-111.

conducts the major part of Northern Telecom's and Bell Canada's research, design, development, and long-range network planning and systems engineering for all phases of telecommunications. Northern Telecom also benefits from research conducted by wholly owned subsidiaries in the United States and the United Kingdom, which allow it to keep up with the latest developments in these sophisticated foreign markets.

Europe

European firms, such as Alcatel, Siemens, and Ericsson, also spend significant sums on R&D.[38] Siemens benefits both from research directly related to communications equipment and advanced research on electronics components and systems as well, whereas Ericsson has invested considerable amounts in research and development of advanced cellular network systems. Alcatel, meanwhile, benefits from government policies to establish France as a technological leader in advanced communications systems, which guarantee incentives for significant investment in R&D.[39] A major disadvantage for European firms compared to their North American and Japanese competitors, however, is the relatively smaller sizes of their domestic markets, which limit attempts to spread the costs of research and development efforts. Alcatel has partly overcome this difficulty by acquiring the international communications equipment operations of ITT.

Many European manufacturers also benefit from R&D conducted by government-owned service providers. For example, France Telecom's research arm, CNET,[40] both provides technical assistance and expertise to the communications provider and other French ministries, and does substantial cooperative research with French manufacturers of equipment. Alcatel is reported to have benefited from work with CNET on developing digital communications networks, and other French producers are currently working with CNET to develop videophones with advanced features.[41] However, some concern presently exists in France that current EC proposals requiring communications providers such as France Telecom to open up their procurement, if adopted, may reduce incentives for the service provider to work as closely with private companies. Other European firms, such as Siemens and Ericsson, also benefit from joint research and technical development with the communications service providers in their respective countries.

Japan

Japanese communications equipment firms in general have invested more in applied research and development than North American and European firms, which have placed a greater emphasis on basic research.[42] Some industry experts believe that this investment has increased the ability of Japanese firms to commercialize their technology. However, a consensus exists among Japanese communications equipment manufacturers that they must invest more in basic research so they can advance technologically in the future.[43] Japanese industry officials and experts also believe that research capabilities in software development in their country greatly lag behind those in countries such as the United States and the United Kingdom. Since software development is so crucial to advanced digital switching systems, Japanese communications equipment manufacturers, such as Fujitsu, have established research facilities in both those countries to gain access to such technology.

Because major Japanese communications equipment producers belong to large integrated electronics and communications equipment conglomerates, they benefit from both their own individual firm's research and access to the central research and development laboratories of their parent corporations[44] Typically, research conducted in facilities of communications equipment units is practical, application-oriented research, resulting in concrete products or technologies for market. However, generic research done on electronics components, materials, and systems by central research laboratories of these corporations is also highly beneficial to the communications, computer, and business system divisions.[45] These various groups all share the costs and benefits of such work, resulting in economies of scope for the company as a whole.[46]

Like their European counterparts, Japanese companies also benefit substantially from R&D conducted by the principal Japanese communications services provider, Nippon Telegraph and Telephone (NTT). NTT has traditionally worked extensively with major Japanese manufacturers to develop new products or technology and has turned over or licensed results of

[38] Government and industry officials, interviews by USITC staff, in Europe, April-May 1991.

[39] Ibid. Also see Herbert Ungerer, *Telecommunications in Europe: Free Choice for the User in Europe's 1992 Market*, Luxembourg: Offices for Official Publications of the European Communities, 1988; E. Sciberras and B.D. Payne, *Telecommunications Industry* (London: St. James, 1986), pp. 38-40; and Howard Rausch, "French City Will Soon Bask In a Fiber ISDN Limelight," *Lightwave*, June 1987, p. 22.

[40] Centre National d'Etudes des Telecommunications.

[41] French industry officials and experts, interviews by USITC staff, April 1991.

[42] Kawamoto Hirotaka, *Key Technology Center: Status and Future Perspectives* (Translation by T. Kusuda, Japan Technology Program/U.S. Department of Commerce), Tokyo, Dec. 1990; "Report on Japanese Technology Policy: The Mechatronic Revolution 1975-85 and Techno-Paradigm Shift: 1985-Present," Unclassified U.S. Department of State Telegram," Tokyo, Jan. 1991; and interviews with U.S., Japanese, and Korean government and industry officials in Japan and Korea in April 1991.

[43] Japanese industry officials, interviews by USITC staff, in Tokyo, Japan, April 1991.

[44] Ibid.

[45] Ibid.

[46] Charles, Monk, and Sciberras, pp. 11-41.

its own development efforts to companies like NEC, Fujitsu, Hitachi, and OKI. Such technology transfer is expected to continue even as increasing pressure is put on NTT to increase its procurement from manufacturers outside the traditional "NTT family".

However, it is likely that a growing number of firms will benefit from this cooperation.[47] For example, since its privatization in 1985, NTT has increased development efforts with other Japanese and even foreign companies, including U.S. manufacturers. Currently NTT employs about 7,300 researchers.

Japanese firms also benefit from research of the Ministry of Posts and Telecommunications (MPT), the principal regulator of communications in Japan. Unlike NTT, or manufacturers themselves, MPT conducts fundamental generic and precompetitive research.[48] MPT also promotes joint academic-industry research on broad, generic themes.

Finally, Japanese communications equipment manufacturers benefit from incentives for research and development to promote advances in Japanese advanced technologies. For example, in 1985, to overcome Japan's perceived relative weakness in this area the Japanese Diet enacted the Key Technology Research Implementation Act to reduce the risks and costs involved in conducting basic research.[49] Under this law, Key Technology Promotion Centers (KTCs) were established under the auspices of MITI, MPT, and the Ministry of Finance.[50] Principal financing of approved projects was provided, using funds from the dividends of government-owned stocks in NTT. Additional funding includes revenues received from the Japan Development Bank, a government financial institution which finances industrial development projects through provision of long-term loans, and from other government monopolies, such as the Japan Tobacco Corporation.

Projects funded by the KTCs are not limited to communications technologies. A large range of advanced technologies, such as semiconductor technologies, advanced materials, supercomputers, next-generation diesel engines, and optical communications, have been included in research projects sponsored by the program. However, under the program, an international telecommunication KTC has been established to develop new technologies for telecommunications systems, machine translation systems for telephones, audio-visual research, and optical communications. Since the program was adopted in 1985, its capital investment fund's budget has risen from $31 million to $210 million.[51] At least 19 projects approved since that time have been directly related to communications systems and networks and have included all the major Japanese communications equipment suppliers.

Market-penetration Efforts

A number of industry experts believe that major European and Japanese producers continue to have an advantage over AT&T in selling in overseas markets because they have developed greater marketing expertise over the years.[52] In return for accepting regulation in its 1913 compromise with the U.S. Government, known as the Kingsbury Commitment, AT&T maintained virtual control over the telephone market and remained protected from significant domestic competition for much of its history. Moreover, it was discouraged from engaging in international marketing activities after the Department of Justice pressured it to sell its European operations in 1924. Finally, because AT&T supplied its own network equipment requirements for more than a century, its need for or interest in marketing was almost nonexistent until recent competitive developments.[53]

Because individual European country markets are not nearly as large as the U.S. market, European companies have traditionally had to seek out other markets to expand sales.[54] Consequently, they had to develop good marketing skills to compete effectively. Meanwhile, aggressive domestic and export competition have pressed the four principal Japanese suppliers to develop marketing expertise.[55] In addition, many European and Japanese companies, such as Siemens, NEC, and Hitachi, were diversified suppliers of other products, such as computers and other electronics products, that were sold in markets that were more competitive than protected communications markets. Many observers believe marketing expertise developed in these competitive markets has helped these companies compete in newly liberalized communications markets as well.

---

[47] Japanese government and industry officials, interviews by USITC staff in Tokyo, April 1991; and Johnson, *MITI, MPT, and the Telecom Wars*.

[48] Officials of Japan's Ministry of Posts and Telecommunications, interviews by USITC staff in Tokyo, April 1991.

[49] Hirotaka, *Key Technology Center: Status and Future Perspectives*.

[50] The official purpose of the Key Technology Center is to provide capital investment funds to industrial consortia and individual companies to develop high-risk, next-generation technology. It accomplishes this by allocating seed money in the form of low-interest or interest-free loans to projects that private sector companies would not likely otherwise undertake due to the high costs and risks involved. The Center finances a maximum of 70 percent of the research and development costs of approved projects conducted by single companies or consortia of companies.

[51] *Japan Key Technology Center: Guide book for Capital Subscription and Financing Systems*, Tokyo: The Japan Key Technology Center, 1991.

[52] Industry and government officials and analysts in the United States, Europe, and Asia, interviews by USITC staff, March-May 1991.

[53] Faulhaber, p. 1.

[54] European industry officials, interviews by USITC staff, April-May 1991.

[55] Industry and government officials and analysts, interviews by USITC staff, in Tokyo, April 1991.

North America

Until 1956, Canadian-based Northern Telecom and its sister company Bell Canada were affiliated with AT&T. However, after the 1956 Consent Decree, the Canadian companies became independent. At first, Northern Telecom benefited from its captive supply arrangement with Bell Canada to generate sufficient sales.[56] However, eventually it found that the Canadian market was not large enough to support desired sales growth.[57] Thus Northern Telecom looked first to less-developed country markets, such as Costa Rica and Greece, to which it exported telephones and traditional switching systems in the early and mid-1960s.[58]

Northern Telecom first entered the U.S. market by selling to independent, non-AT&T telephone companies. However, even before the 1984 divestiture, AT&T's regional operating companies began to purchase digital central office switches from Northern Telecom. Similar network standards in both Canada and the United States permitted Northern Telecom to sell unimpeded and consequently the firm set up extensive production facilities and operations in the United States. Success in the sophisticated U.S. market has enabled Northern Telecom to generate sales to many other countries throughout the world, including Japan and Europe. Recently, it acquired a major interest in the communications business of the third-leading British communications equipment company, Standard Telephone and Cable (STC), to better establish itself in the potentially lucrative EC market. Northern Telecom has also invested in production facilities and joint venture arrangements in a number of developing countries in Latin America and Asia.

A number of industry analysts assert that despite similar backgrounds, Northern Telecom has developed a better marketing orientation than AT&T, paying greater attention to customer requirements.[59] For example, several years ago Northern won a major switching contract from Japan's NTT principally due to its willingness to transfer technology, including software source code, to its customer.[60] Other industry experts believe, however, that Northern may have sacrificed future marketing advantages by transferring such technology so readily. These experts point out that much of the value in sales of advanced network communications systems comes from future upgrades and aftersales support to their customers.

Restrictions on AT&T's foreign market activities were lifted by the 1982 MFJ. Minimal previous experience in marketing equipment to users other than its own operating companies led AT&T to enter foreign markets by establishing joint ventures with local firms in the United Kingdom, Denmark, Italy, the Netherlands, and Spain.[61] A similar strategy has been used for entering Asian markets, such as Korea.

Some industry experts believe that AT&T's success in its overseas activities has been hampered by lack of previous marketing experience.[62] They indicate that AT&T has been less willing than foreign competitors to modify its products to the specifications of local communications authorities. Moreover, the industry analysts say the company has taken a much shorter term view in its sales strategies, while foreign competitors have better understood the need to establish long-term commitments and relationships with potential customers.[63] For example, the significant European and Japanese investments in China are unlikely to return substantial profits until the next decade. This contrasts with AT&T's concentration on markets where it can obtain more immediate returns and the minimal investments it makes in markets where potential profits may not result for a number of years.

The major competitive advantage of AT&T in foreign markets is its reputation for the sophisticated network it has created in the United States, considered by many as the most technologically advanced network in the world. For this reason, some industry experts believe it is not in AT&T's best interest to accede to demands that it readily transfer technology to win network contracts.[64] They also believe that AT&T has progressively developed marketing expertise since competition emerged in the U.S. market over the past decade and since the company was allowed to compete again in international markets.

Europe

European-based firms such as Alcatel and Siemens have established or acquired manufacturing operations in many of the foreign markets in which they operate. Because telecommunications authorities (TAs) in most countries prefer to work with local producers, the European firms have effectively used this market penetration strategy.

European firms were early entrants in less developed foreign markets, especially ones in which their countries had established major colonial ties, while AT&T was restricted from entering foreign markets. Although European firms initially entered these markets primarily through exports, many local governments required them to develop manufacturing facilities in these countries or establish joint ventures with local companies. To allay local concerns, as well as spread their own risks, European firms have often been willing to invest in communications ventures in

[56] U.S. industry officials, interviews by USITC staff, March 1991.
[57] Ibid.
[58] Ibid.
[59] Industry officials and analysts, interviews by USITC staff in the United States and Japan, March-May 1991.
[60] Industry and trade analysts, interviews by USITC staff in Tokyo, April 1991.
[61] U.S. industry officials, interviews by USITC staff, 1991.
[62] Industry and government officials, interviews by USITC staff, in the United States, Europe, and Asia, 1991.
[63] Ibid.
[64] Ibid.

foreign markets, with relatively low initial percentage participation.[65]

Substantial local presence has helped the European firms in selling to less developed country markets, where government officials desire local facilities that employ their own citizens and also result in industrial development and transfer of technology to their countries. Ericsson has traditionally been very successful in less developed markets, particularly Latin America, and Siemens and Alcatel are now competing for business in India and China. Many industry observers believe that their previous experience in establishing local operations in former colonial markets such as North Africa and Asia will help them in their current efforts to enter these new markets.

Some industry analysts believe that the experience gained by European manufacturers in establishing manufacturing and service facilities in other European and developing country markets may also be a potential advantage in more advanced markets for communications equipment.[66] In countries such as the United States, service providers, such as the RHCs and the independents, desire close relationships with and proximity to their major equipment providers. Thus far, technological considerations have prevented firms, such as Alcatel, Siemens, and Ericsson, from gaining large network contracts in the large U.S. market. However, all three companies have established a significant operating presence in the United States and could benefit from such presence in the future.

Japan

Japanese firms, such as NEC and Fujitsu, have been more export-oriented than European companies in entering foreign markets for communications equipment.[67] At first, these Japanese firms exported to less developed countries in Asia and Latin America. Initially they had difficulty penetrating such markets because of both a heavy reliance on exporting Japanese-made equipment to these markets and a propensity for managing local operations with Japanese expatriates. In Brazil, for example, European suppliers such as Ericsson had more success than Japanese firms because of their willingness to establish local manufacturing facilities, managed largely by Brazilian personnel. In recent years, however, Japanese equipment producers have become more sensitive to concerns of local officials and the need to establish a strategy based on more than exports, especially in communications equipment markets. Accordingly, they have now established local manufacturing and assembly operations in many of their foreign markets. Nevertheless, management of foreign affiliates of Japanese firms remains largely in the hands of Japanese nationals.

Japanese producers of communications equipment have been more willing than other foreign firms to penetrate important markets, such as the United States, by initially settling for sales of less substantial equipment such as transmission components, rather than going immediately after large network switching contracts.[68] Their strategy is to establish themselves in the short run as reliable suppliers of quality equipment and demonstrate their commitment to their customers by providing superb aftersales support. Fujitsu, for example, has demonstrated its long-term commitment by involving itself for several years in extensive testing and evaluation of its network switching system with a major operating company in the United States for which it still has not received a contract.[69]

Multinational

The number of substantial mergers, acquisitions, and consolidations (figure 5-1) occurring among communications firms in the international market in the past 5 or 6 years suggest a shakeout is occurring in the industry that will ultimately reduce the number of major players.[70] Most experts agree that rising economies of scale in the research and development of digital central office switches is driving this trend.[71] Only the firms capable of funding such research will remain in the market.

However, another factor at play is the attempt by the major communications equipment players to form partnerships with locally based firms to gain market entry. Most communications markets are still less than fully open, because of either nationalistic policies of government-controlled communications markets or reluctance of communications providers to deal with suppliers that are not already part of their embedded base. Thus, Siemens invested in the British joint venture GEC-Plessey Telecommunications (GPT), not only to obtain a portion of the newly liberalized British market, but to take advantage of GPT's own interest in the smaller U.S. switchmaker, Stromberg-Carlson, to help increase its presence in the U.S. market (figure 5-2). For similar purposes, AT&T has established relationships with the Netherland's Philips, Italy's Italtel, and Korea's Goldstar to help it penetrate markets that would otherwise be closed to it.[72] In 1987, France's Alcatel significantly increased its presence in Germany when it obtained a major interest

[65] Industry officials, interviews by USITC staff, in France and Germany, April 1991.

[66] Industry officials, interviews by USITC staff, in the United States, Europe, and Asia, March-May 1991.

[67] Industry and government officials, interviews by USITC staff, in Japan, April 1991.

[68] U.S. and Japanese industry officials, interviews by USITC staff, in the United States and Japan, March-May 1991.

[69] Ibid.

[70] Hausman and Kohlberg.

[71] Ibid.

[72] Industry officials, interviews by USITC staff, in the United States, Japan, and Europe, March-June 1991; and Eli M. Noam, "Telecommunications in Transition," *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, edited by Robert W. Crandall and Kenneth Flamm, (Washington, DC: The Brookings Institution, 1989, pp. 257-297).

Figure 5-1
Major Communications Equipment Business Combinations

Joint Ventures		
Year	**Companies (Headquarters Location)**	**Product**
1983	AT&T (U.S.) Philips (Netherlands)[1]	Network Equipment
1984	AT&T (U.S.) Goldstar (Korea)	Fiber Optic Transmission Equipment
1986	Corning (U.S.) Siemens (Germany)	Fiber Optic Transmission Equipment
1989	General Electric (U.S) Ericsson (Sweden)	Cellular Communication Equipment
1989	IBM (U.S.) Siemens (Germany)	PBX Distribution
1990	AT&T NSI (Netherlands) Italtel (Italy)	Network Equipment

Acquisitions			
Year	**Buyer**	**Seller**	**Product**
1985	Plessey (U.K.)	Stromberg-Carlson (U.S.)	Rural Network Equipment
1986	Siemens (Germany)	GTE (U.S.)	European Network Equipment Operations
1988	AT&T (U.S.)	GTE (U.S.)	U.S. Network Equipment Operations
1988	British Telecom (U.K.)	Mitel (Canada)	PBX Equipment
1989	GEC (U.K.)	Plessey (U.K.)	Network Communication Equipment Operations
1989	Siemens (Germany)	IBM Rolm (U.S.)	PBX Equipment
1990	Northern Telecom (Canada)	STC (U.K.)	Network and Transmision Equipment

[1] Philips reduced its stake in this joint venture to 15 percent in 1989. In 1990, it sold its remaining stake to AT&T NSI.

Figure 5-1—Continued
Major Communications Equipment Business Combinations

Investments				
Year	Buyer	Seller	Percent Interest	Product
1987	ITT[2] (U.S.)	Alcatel N.V (Netherlands)	37	Network and Terminal Equipment
1989	Siemens (Germany)	GEC-Plessey Telecommunications(U.K.)	40	Network Equipment
1990	AT&T (U.S.)	Italtel (Italy)	20	Transmission Equipment
1990	Italtel (Italy)	AT&T NSI (Netherlands)	19.5	Network Equipment
1990	Alcatel N.V. (Netherlands)	Telettra (Italy)	78	Transmission Equipment
1990	Fujitsu Ltd. (Japan)	Fulcrum Commmunications (U.K.)	75	Transmission Equipment

[2] In 1990, ITT reduced its share in Alcatel to 30 percent.

Source: Compiled by staff of the U.S. International Trade Commission from information in company annual reports.

in the ITT subsidiary, Standard Elektrik Lorenz of Stuttgart, Germany.[73]

External Factors

Regulation

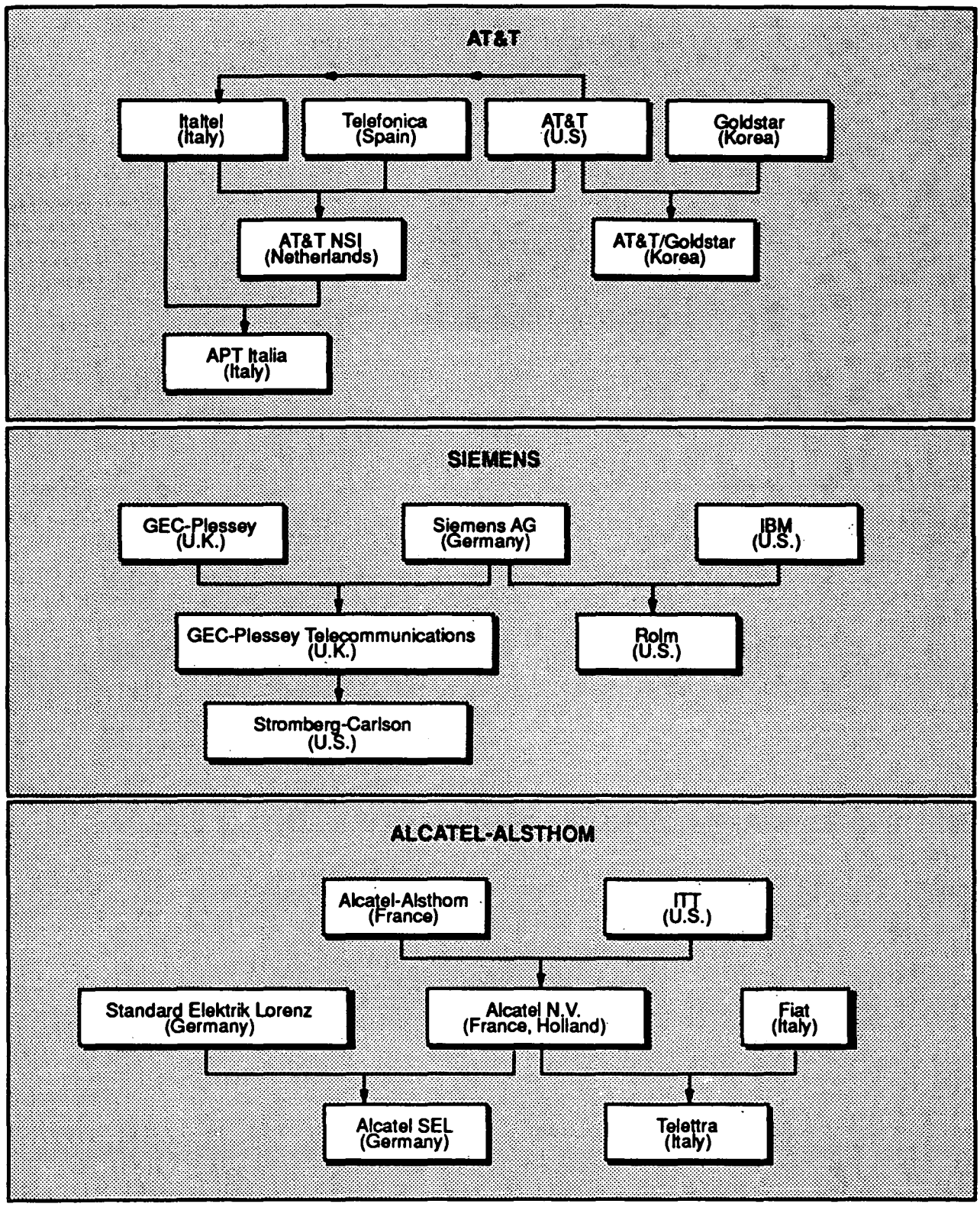
Competition in communications services and equipment markets is a relatively recent phenomenon and the extent of liberalization has been uneven worldwide. In the past decade, countries like the United States and the United Kingdom have radically reformed their regulatory structures and liberalized their communications markets. Although many of these changes expanded opportunities for domestic suppliers, they also significantly increased opportunities for foreign suppliers in the two markets.

Overall, it would appear that British firms have been less successful than U.S. companies in adjusting to increased foreign competition generated by deregulation.[74] Major difficulties have been experienced by previously successful British-based firms. For example, British-based Plessey first merged with British-based GEC and then had to seek assistance from German-based Siemens to remain afloat in the communications equipment market.[75] Similarly, the United Kingdom's third-leading equipment supplier, STC, had to be rescued by Canadian-based Northern Telecom. Northern Telecom, in fact, appears to have benefited the most from regulatory changes and liberalizations in both the United States and the United Kingdom. Regulatory changes in most of the other European markets, including Germany and France, have been much more gradual than those in the United States, and the United Kingdom. However, EC officials are pressuring telecommunications administrations in member countries to open up competition in their markets as a part of Europe's move towards a single market. Communications equipment suppliers from outside the EC hope that any benefits from regulatory adjustments in European communications markets will be indiscriminate with respect to suppliers.[76] However, just in case they are not, North American and Japanese equipment producers are establishing production facilities and jobs within EC borders, to take advantage of integration of that market.[77]

[73] John Marcom, Jr., "First Europe, Then the World," *Forbes*, Oct. 29, 1990, pp. 134, 135.
[74] Sciberras and Payne, p. 52.

[75] Peter F. Cowhey, "Telecommunications," *Europe 1992: An American Perspective*, edited by Gary Clyde Hubauer, (Washington, DC: The Brookings Institution, 1990), p. 159.
[76] Industry officials, interviews by USITC staff, in the United States and Japan, March-May 1991.
[77] Ibid.

Figure 5-2
Major communications equipment business alliances of AT&T, Siemens, and Alcatel



Source: Compiled by staff of the U.S. International Trade Commission from information in company annual reports.

Although Japan also underwent major restructuring, thus far it appears that other Japanese suppliers outside the "NTT family" have benefited the most from liberalization of equipment markets.[78] Japanese producers of consumer electronics equipment, business machines, and even chemicals, such as Sony, Matsushita, Murata, and Sumitomo, now compete with traditional suppliers of communications equipment in markets for advanced transmission and terminal equipment. In addition, some foreign suppliers, like Northern Telecom and Motorola, have enjoyed limited, but increased success in the Japanese market.

Embedded Base

Traditional suppliers of communications equipment in all major equipment-producing countries continue to benefit from the installed equipment, known as the embedded base, in their national communications networks. In all of the major-equipment-producing nations domestic manufacturers supply between 85 and 100 percent of the public network embedded base.[79] Operators of communications networks are reluctant to change or add new equipment suppliers, because it is difficult to maintain a smoothly functioning network with potentially incompatible equipment and standards. Even in the liberalized U.S. market, AT&T and Northern Telecom continue to benefit greatly from the embedded base of their equipment in the principal long distance and regional networks.[80] In fact, their entrenched positions in the world's largest communications market are principal competitive advantages, allowing them to cover large portions of marketing and development costs from sales in this market.

European suppliers also benefit from entrenched positions in their respective national markets. However, because none of the European markets by itself is large enough to fully support its own national supplier, both Alcatel and Siemens are fighting to attain a position in the integrated EC similar to that presently held by the two North American suppliers in the U.S. market. Both of these companies have established significant manufacturing and sales operations throughout Europe to integrate their equipment into the embedded base of future European networks.

Although the four major Japanese suppliers also benefit from entrenched positions in the very lucrative and rapidly growing Japanese market, they must obtain significant shares of foreign markets if they are to cover rapidly increasing development costs.[81] NEC and Fujitsu have successfully penetrated foreign markets for network switching gear in Latin America, Asia, and the Middle East, whereas Hitachi and other Japanese suppliers have found niches in foreign markets for advanced transmission equipment. In the United States, for example, Hitachi has sold lasers and other optoelectronic components for network fiber optic systems to AT&T and Rockwell Corp. as well as complete fiber optic systems to many of the independents and RHCs.

Because of the importance of the embedded base, major competitors from Japan and Europe are making costly investments in China and India even though those markets currently offer little short-term profit or gain. Many experts believe that the long-term pay out from investment in these large countries is likely to be much greater than in more mature markets where telephone penetration is already high. Reportedly, Japanese and some European firms are willing to sacrifice immediate profits in the expectation of obtaining much larger profits in the future in these less developed countries. They hope that once these largely populated areas do have the resources to establish modern communications infrastructures, their companies will have established themselves as part of the embedded base. Thus, these firms will be favored suppliers to the network operators in those potentially lucrative markets.

Export Financing

Although less developed countries in Asia, Latin America, and Africa represent large, relatively untapped markets for communications equipment for major North American, European, and Japanese suppliers, such countries lack resources to fund large development projects. Accordingly, they depend extensively on long-term financing from outside sources.[82] Though substantive documentation is lacking, discussions with industry and government officials in the United States, Europe, and Japan indicate that major European and Japanese suppliers benefit more than U.S. producers from government financing, loan guarantees, and aid to developing countries that is tied to purchases of communications equipment from national suppliers.[83]

One type of financial assistance provided by some countries is mixed credits, which combine grants and low-interest loans, to developing countries. Although the United States does not offer such financing, Japan, Germany, France and many other equipment-producing countries do.[84] Companies such as NEC, Alcatel, and Siemens, for instance, all benefited to some degree from mixed aid credits to China that

[78] Industry and government official and analyst, interviews by USTIC staff in Tokyo, April 1991.

[79] U.S., Japanese, and European industry officials, interviews with USITC staff, March-May 1991.

[80] U.S. industry officials and officials of U.S. affiliates of foreign-based firms, interviews by USITC staff, March 1991.

[81] Industry and government officials, interviews by USITC staff in Tokyo, April 1991.

[82] Government and industry officials, interviews by USITC staff, in the United States, Europe, and Japan, March-May 1991.

[83] Industry and government officials, interviews by USITC staff, in Japan, Europe, and the United States, 1991.

[84] James McGregor, "China's Political Clout, Growing Prowess in Trade May Prove Troublesome to U.S.," The *Asian Wall Street Journal Weekly*, May 6, 1991; and Robert M. Orr, Jr., *The Emergence of Japan's Foreign Aid Power* (New York: Columbia University Press, 1990).

totaled $3.2 billion in 1988, a significant portion of which was used to fund communications projects.[85]

U.S. Government support for export financing of communications equipment is small relative to that of other countries. The U.S. Export-Import Bank offers financing packages with interest rates of 8-9 percent over a 10 year period with a grace period of 6 months. In contrast, the Governments of Japan and France reportedly offer financing for communications equipment exports at rates of as low as 3.5 percent for 30 years, with a 10 year grace period.[86] Moreover, French, German, and Japanese Governments reportedly assist domestic companies in arranging financing packages before an award is even made. In contrast, companies in the United States and the United Kingdom only arrange financing packages after receiving the contract award.

Marketing Assistance

In certain countries, foreign commercial posts at embassies can be crucial in assisting foreign companies entering international equipment markets.[87] Many industry analysts say that Japan, Germany, France, and the United Kingdom all maintain large commercial embassy staffs that include communication industry specialists.

Japanese firms benefit from government-sponsored trade promotion and marketing activities on their behalf in major markets throughout the world. The Japan External Trading Organization (JETRO), for example, not only conducts detailed marketing studies of communications requirements of principal foreign markets, but has also established offices throughout the world to provide assistance to Japanese businessmen.

Although the U.S. Department of Commerce is charged with providing similar marketing services to U.S. business in important markets throughout the world, including Japan, the resources at its command do not approach those available to Japanese businessmen. For example, the American Electronics Association documented that in 1988 JETRO provided funding of more than $13 million to field 74 officers in 9 U.S. cities to help Japanese businessmen market their products.[88] In that same year, corresponding U.S. Government funding to maintain 10 U.S. Department of Commerce foreign commercial officers in 2 Japanese cities amounted to less than $4 million.[89]

[85] McGregor, "China's Political Clout."

[86] U.S. Department of Commerce, International Trade Administration, *The Competitive Status of the U.S. Electronics Sector from Materials to Systems*, (Washington, DC: GPO, April 1990), p. 139.

[87] Industry analysts, interviews by USITC staff, in Europe, May 1991.

[88] American Electronics Association, *The U.S.-Japan Export Promotion Gap*, 1991; and interviews by USITC staff with U.S. and Japanese government and industry officials in Tokyo, in April 1991.

[89] Industry and government officials, interviews by USITC staff in the United States and Japan, April 1991.

Procurement

Procurement of communications equipment by communications service providers in major markets has traditionally been from nationally based suppliers. In the United States, the dominant communications service provider, AT&T, historically procured almost all of its network and terminal equipment from its captive equipment supplier, Western Electric. However, after competitive service providers entered the market in the 1970s, and the RHCs were divested from AT&T in 1984, much of the U.S. market for terminal and network equipment became open to competitive supply from a range of domestic and foreign equipment suppliers.

Because no other countries have witnessed the radical changes in regulation and competition that occurred in the United States in the past several decades, government procurement activities in other countries have largely resulted in much more closed communications equipment markets than in the United States.[90] Despite recent decisions permitting a degree of competition in Canada's terminal equipment markets, its existing regulatory structure has permitted Northern Telecom to maintain a captive supply relationship with Bell Canada. A written agreement between the two companies permits Bell Canada to purchase equipment from another supplier, only if Northern Telecom cannot or will not supply the equipment.[91] Consequently, when Bell Canada needs a switch, "it can seek bids from AT&T or Siemens only if Northern Telecom is not interested."[92]

In most remaining major communications markets worldwide, communications authorities remain owned, or controlled, by the government, and procurement decisions still favor nationally based suppliers.[93] For example, even though Japan's principal communications provider, NTT, was theoretically privatized in 1985, a majority of its shares remain government-owned. Political rather than economic pressures from the United States rather than market forces appear to have been most responsible for increasing market opportunities for foreigners in that market.[94] Northern Telecom apparently benefited from some of these market-opening pressures when it sold a major switching system to NTT several years ago.

[90] Charles, Monk, and Sciberras.

[91] U.S. Department of Commerce, *U.S. Telecommunications in a Global Economy: Competitiveness at a Crossroads* Report from the Secretary of Commerce to the Congress and the President of the United States as Mandated by Section 1381 of the Omnibus Trade and Competitiveness Act of 1988, (Washington, DC: U.S. Department of Commerce, August 1990), pp. 125 and 126.

[92] Ignatius Chithelen, "Canada Inc.," *Forbes*, Nov. 28, 1988, p. 226-27.

[93] Charles, Monk, and Sciberras.

[94] For background on U.S.-Japan negotiations concerning procurement of Japanese communications equipment, see USITC, *Operation of the Trade Agreements Program, 37th Report, 1985*, USITC publication 1871, 1986, p. 159, and USITC, *Operation of the Trade Agreements Program, 41st Report, 1989*, USITC publication 2317, pp. 106-108.

However, NTT continues to procure most equipment from its traditional suppliers, NEC, Fujitsu, Hitachi, and OKI, and less than 4 percent of its total purchases are from foreign suppliers.[95] Market liberalization has resulted in new, competitive, long distance common carriers to NTT in the Japanese market. Since these companies depend greatly on interconnection to the NTT network to provide service, they have also initially procured most critical network equipment from Japanese suppliers most familiar with NTT's network.[96] However, both NTT and the new common carriers, such as Japan Telecom, and Japan Teleway, have increased their procurement of non-network equipment such as computers, components, and terminals from U.S. and other foreign suppliers.

The United Kingdom established the most liberal procurement policies in the European Community, largely because of the privatization of its major service provider, British Telecom (BT). In addition, Mercury Communications, has been allowed to enter the market to provide competition to BT in basic services. Although the British Government owns 48 percent of BT, it reportedly encounters very few political limitations when purchasing equipment.[97]

Other major European countries, such as France and Germany, have liberalized procurement practices to a much lesser extent than the United Kingdom. Although telecommunications authorities in both countries have separated service and regulatory activities, both remain strictly under the control of national governments. Much evidence suggests that the French and German communications service providers, France Telecom and DBP Telekom, continue to procure major network communications equipment from national suppliers. In 1984-88, for example, DBP Telekom awarded 99.5 percent of its contracts to national firms.[98] In France, the Netherlands, the United Kingdom, and Portugal, 100 percent of communications government procurement contracts for communications equipment went to national firms.[99]

The European Community would like to open up procurement in member states. Previously, communications was one of four excluded sectors not subject to EC-wide or international procurement rules.[100] However, a directive on public procurement including the four excluded sectors was formally adopted by the EC in September 1990.[101] Even though they are not government-controlled entities, British Telecom and Mercury Communications will be covered along with the other member state telecommunications authorities under this directive.

Although opening up public procurement would theoretically give non-EC firms, including U.S. firms, access to one of the largest sectors of the EC communications equipment market, provisions in the procurement directive would likely provide more advantages to EC firms than to foreign firms. The directive stipulates that for communications contracts over ECU 600,000, which would include most major switching system contracts, EC bids may be accepted if they are less than 3 percent higher than non-EC bids.[102] In addition, bids can be rejected if the total value of the equipment has less than 50 percent EC value-added content. However, since 60 to 80 percent of network switching system developments are related to software development, usually conducted in the network suppliers' home country, most non-EC firms oppose this stipulation.

Improvements to the GATT public procurement code are currently being negotiated in the Uruguay Round of multilateral trade talks. The GATT code establishes an international framework for rules and procedures concerning government procurement. The EC proposed a far reaching expansion in GATT code coverage which would include communications equipment procurement. However, in return, the EC demanded that AT&T and the RHCs be covered by proposed GATT procurement rules, since current arrangements by those companies effectively closed at least 30 percent of the U.S. market to foreign suppliers. The U.S. Government says its telecommunications service providers are already open to foreign suppliers, while U.S. firms could continue to be excluded from supplying government-owned or controlled communications monopolies in the EC unless they comply with the EC procurement directive.

Standards

Most North American, European, and Japanese firms indicated that liberalization of communications markets worldwide would make it more imperative to have international, rather than individual country standards.[103] These firms added that an increasing need for network equipment suppliers to gather a greater portion of their sales from world markets would strengthen that imperative. However, many industry analysts believe that developing international standards is difficult because national and regional standards bodies and the firms they represent find it in their best interest to promote and preserve their own established standards.[104] Even though protocols have been developed to allow two different operating systems to communicate, the conversion process often takes too long and wastes transmission time.

---

[95] Japanese government and industry officials, interviews by USITC staff in Tokyo, April 1991.

[96] Japanese industry officials, interviews with USITC staff, April 1991.

[97] British industry and government officials, interviews by USITC staff, in the United Kingdom, April and May 1991.

[98] See USITC, *The Effects of EC Integration*, USITC publication 2204, July 1989, p. 4-18.

[99] Ibid.

[100] The four excluded sectors are water, energy, transport, and telecommunications.

[101] EC Council Directive 90/531, *Official Journal of the European Communities*, No. L 297 (Sept. 17, 1990).

[102] Ibid.

[103] Government and industry officials, interviews by USITC staff, in the United States, Japan, and Europe, March-May 1991.

[104] Ibid.

In the past, the United States benefited from uniform network communications standards throughout the country due to AT&T's prominent position in manufacturing and services.[105] Because of the involvement of AT&T and GTE in helping establish communications networks in Canada, similar standards prevailed in that country as well. In the EC, different standards evolved in each country, resulting in different equipment requirements in each market. For example, it was not possible to take a central office switch from Germany and install it in France without adaptation.[106] Although U.S. and European communications equipment manufacturers have played an important role in establishing the Japanese communications industry and network, Japanese standards are significantly different from those in North American and Europe.

Because of the difficulty of maintaining a smoothly functioning communications network with potentially incompatible equipment, telecommunications authorities in different countries prefer to purchase equipment that is proven to be compatible with their own network standards. Therefore, incompatible standards between the United States and major foreign competitors in Europe and Japan make it difficult for suppliers to sell equipment outside their own domestic markets.[107] Some European manufacturers claim that Bellcore standards used by the RHCs follow AT&T standards and, thus, make it harder for foreign firms to sell in the important U.S. market.[108] In order to sell equipment to RHCs, some European companies have reported they must spend significant amounts on adaptation and testing.[109] Because of the standard differences in overseas markets, AT&T has also incurred tremendous costs in adapting equipment for the European market. As a result, AT&T spends about 17 percent of overseas sales on development costs for equipment modification.[110]

U.S. firms, such as AT&T and Motorola, found standards to be a particularly onerous barrier to trade in Japan when they attempted to enter that market in the early 1980s. To address some issues of market access, the United States initiated a series of new trade talks known as market-oriented, sector-selective (MOSS) talks in 1985. These talks focused on identifying and removing tariff and nontariff barriers in selected Japanese sectors, including telecommunications equipment and services, under the assumption that increased access to Japanese markets would lead to a corresponding increase in export sales of competitive U.S. products.[111]

For telecommunications, the MOSS negotiations were conducted in two stages. The first phase of negotiations centered on the issues of standards, certification, testing of terminal equipment, and value-added network (VAN) services. The United States sought greater transparency in Japan's process of rulemaking and standards-setting, reduced numbers of standards, and a liberalized market for terminal equipment, by adopting the U.S. criterion of "no harm to the network."[112] The negotiations for the first phase were concluded in April 1985 when an agreement was signed on wire-line telecommunications issues that achieved most of the U.S. objectives. One important achievement was the influence of the talks on the final language of the Telecommunications Business Law, enacted in April 1985, and its implementing regulations, which established a legal framework to greatly liberalize the Japanese communications market.[113]

The second phase of the MOSS talks, begun in mid-1985, focused on radio communications. In addition to issues such as standards, licensing, and approval of equipment, an issue of prime importance to U.S. radio and cellular service and equipment suppliers was the allocation of radio frequencies to new service providers and government procurement of radio equipment.[114]

Although U.S. Government and industry officials considered both phases of the MOSS talks to be generally successful, concern remains over the ability of foreign firms to increase market shares of communications equipment over the long run and whether the Japanese will allow U.S. and other companies to be more than marginal players in their market.[115] Accordingly, the United States and Japan instituted a MOSS oversight committee composed of U.S. and Japanese industry and trade officials. This committee meets regularly to assess the effectiveness of agreements previously reached by the two countries. Although U.S.-based companies were generally satisfied with the results of recent bilateral trade negotiations, they believe it is imperative that the United States maintain constant pressure on the Japanese on issues of standards, licensing, and procurement of communications equipment.[116]

---

[105] Industry and government officials, interviews by USITC staff, in the United States, Europe, and Asia, March-May 1991.

[106] European industry officials, interviews by USITC staff, in Europe, April-May 1991.

[107] Industry and government officials, interviews by USITC staff, in France and Germany, April 1991.

[108] European industry officials, interviews by USITC staff, April-May 1991.

[109] Ibid.

[110] U.S. industry officials, interviews by USITC staff, March-May 1991.

[111] For background on the MOSS talks see USITC, *Operation of the Trade Agreements Program, 37th Report, 1985*, USITC publication 1871, 1986, p. 159; and U.S. General Accounting Office, *U.S. Japan Trade: Evaluation of the Market-Oriented Sector-Selective Talks*, Report to the Honorable Lloyd Bentsen, U.S. Senate, GAO/NSIAD-88-205 (Washington, DC, July, 18, 1988).

[112] U.S. General Accounting Office, *U.S. Japan Trade: Evaluation of the Market-Oriented Sector-Selective Talks.*

[113] Ibid.

[114] Ibid.

[115] U.S. government officials, interviews by USITC staff, in Tokyo, April 1991.

[116] U.S. industry officials, interviews by USITC staff in the United States, Korea, and Japan, March-May 1991.

Summary

The evolution of technological, regulatory, and economic conditions over the past century has increased the competition in communications equipment markets in the United States and other foreign markets. Even though the United States remains by far the most open market in the world, economic and trade demands in other countries are placing pressure on telecommunications authorities to move toward more liberalized communications markets.

This chapter has reviewed how certain internal factors of major global producers, such as their technology, industry structure, manufacturing techniques, research and development, and efforts at market penetration appear to have affected producers' present ability to compete in this industry. For example, technological diffusion has decreased the U.S. producers' lead over their principal foreign competitors. Moreover, advanced manufacturing techniques, more focused research and development, and greater experience in marketing have enabled some firms to compete better than others in world markets.

Finally, external factors, such as government regulation, embedded base, trade policies, procurement, and standards in various countries, have also influenced the ability of producers to compete in global markets for communications equipment. For instance, greater efforts at deregulation and liberalization in some markets appear to have led to greater foreign penetration than in markets where change has been more gradual. Moreover, government trade policies, such as tied aid and procurement policies of telecommunications authorities appear to be more beneficial to firms in some countries than in others.

Because the global communications equipment industry is dominated by a relatively few major producers of network switching, transmission, and terminal equipment, the discussion in this chapter has been at the level of the firm. Furthermore, the discussion presented in this chapter is an evaluation of the views of industry analysts and representatives in the United States, Europe, and the Far East. The following chapter provides a quantitative assessment at the national level of the impact of the external and internal factors on the international competitiveness of the communications equipment industry.

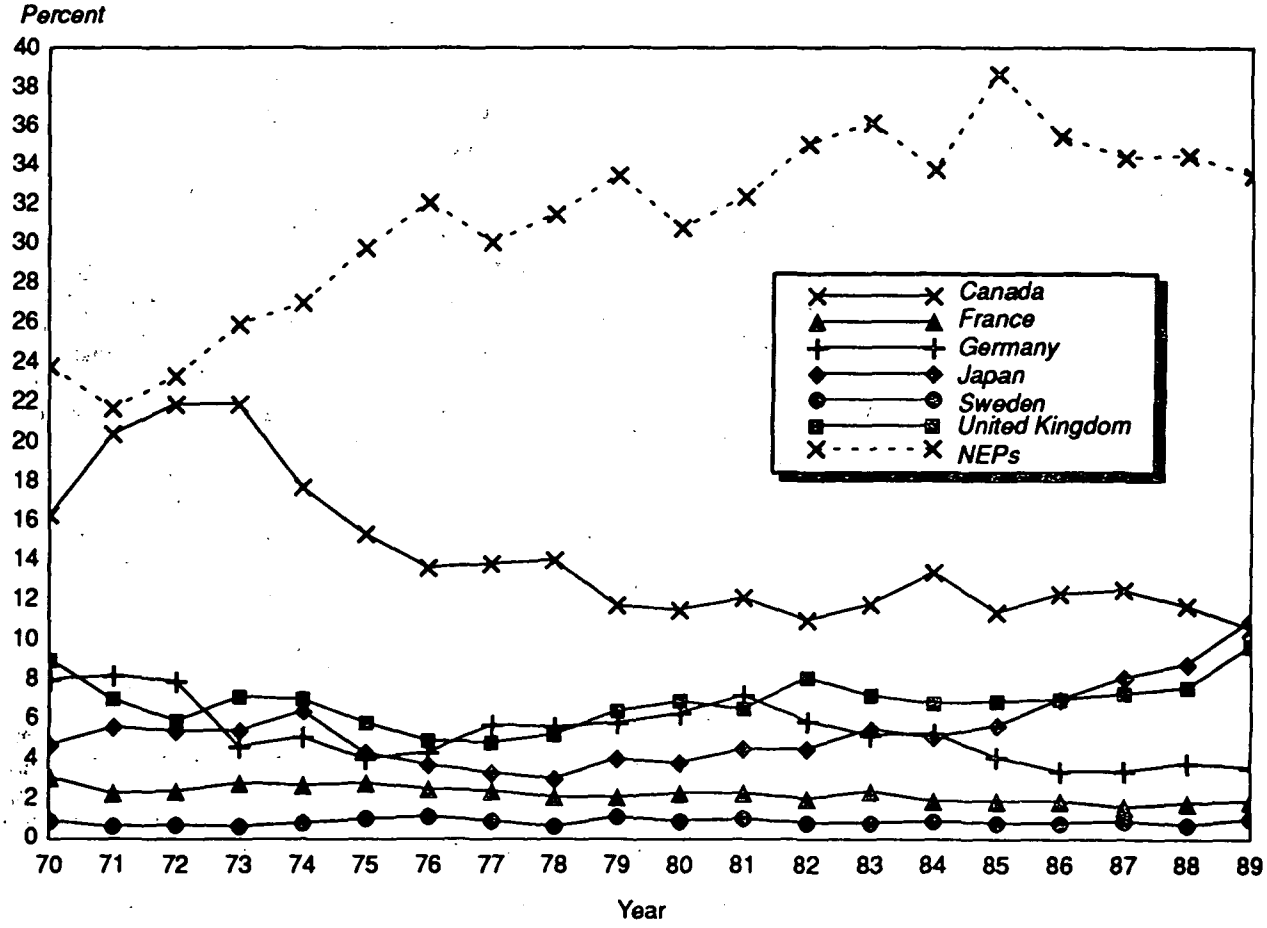
CHAPTER 6
QUANTITATIVE ANALYSIS OF THE INDUSTRY

Introduction

This chapter uses the framework presented in chapter 3 to analyze U.S. competitiveness in the communications equipment industry. In this study, U.S. competitiveness is measured by comparing U.S. exports of communications equipment with those of its principal competitors in a given market. This measure of competitiveness will be referred to as relative export performance. Relative export performance is used to measure competitiveness in two market segments: (1) the markets of the major competitors of the United States, the other major equipment-producing (MEP) countries, and (2) the markets of the nonmajor equipment-producing (NEP) countries. The other MEP countries are Canada, France, Germany, Japan, Sweden, and the United Kingdom. The Commission chose a sample of countries that would represent OECD countries, newly industrialized countries, and developing countries for the NEP market segment. This sample of NEP countries includes the following: Australia, Brazil, Greece, Indonesia, Jordan, South Korea, Malaysia, Mexico, New Zealand, the Philippines, Poland, Saudi Arabia, Spain, Thailand, Turkey, and Venezuela.

Figure 6-1 shows the distribution of U.S. exports between the individual MEP markets and the NEP markets collectively over 1970-1989, the period analyzed in this study. As shown, the NEP countries became a more important market for U.S. exports. The principal NEP markets for U.S exports were Mexico, Brazil, and South Korea. In the case of the other MEP markets, Canada was the principal market for U.S. exports throughout most of the period. The percentage of U.S. exports to the French and Swedish markets remained relatively constant during 1970-89. The Japanese market became more important as the percentage of U.S. exports to this market increased after 1985.

Figure 6-1
Percentage of U.S. exports of telecommunications apparatus destined for the other MEP countries and NEP countries, 1970-89[1]



[1] Group 724, SITC, Revised.

Source: United Nations Online Trade Database, NIH Computer Center.

The external and internal factors shown in figure 3-1 of chapter 3 were considered by the Commission most likely to have determined relative export performance in each market segment. These factors were selected after evaluating the views of industry analysts and representatives. The external factors consist of government policies and macroeconomic variables. Of the government policies discussed in chapter 4, regulation, procurement, export financing, and export controls were identified as important determinants of competitiveness in the communications equipment industry. Procurement policies were the only government policies for which a proxy could be developed. The lack of necessary data did not permit quantification of the other government policies. With respect to the macroeconomic variables, annual wages per employee were used in the analysis as a proxy for labor costs and exchange rates were used to reflect the impact of relative price movements on trade flows in general.

The internal factors include the level of technical expertise, R&D expenditures, manufacturing techniques, and penetration efforts into foreign markets. Penetration efforts were not quantified due to lack of necessary data.[1] Chapter 5 analyzed how the interaction between the quantifiable and nonquantifiable factors has likely led to the current structure of the global communications equipment industry.

This chapter assesses the impact of the quantifiable external and internal factors on U.S. export performance relative to the other MEP countries. Regression analysis, a statistical technique, is used to determine which of these factors have been significant[2] in explaining relative export performance. This statistical technique also permits an analysis of which factors have had the most influence on relative export performance. These estimates of influence are referred to as beta weights (see appendix G for a further explanation of beta weights).

The following section provides a comparative assessment of the principal results of the analysis. Subsequent sections provide the methodology and quantitative results for the individual market segments. A technical presentation of the data, statistical analysis, and findings is in appendix G.

Comparative Assessment of Principal Results

The quantitative analysis in this chapter assessed the impact of the quantifiable external and internal factors on the measure of competitiveness selected for this study—the export performance of the United States relative to the other MEP countries in the NEP and MEP markets. This analysis indicated that not every factor was always significant in explaining U.S. competitiveness in the global communications equipment industry. In the case of the NEP markets, the significant factors did explain a substantial portion of the variation in relative export performance. For the other MEP markets, the amount of variation explained by the significant factors was in a range similar to that for the NEP markets. However, for the other MEP markets, fewer factors were significant and more factors had the opposite impact of what was expected than in the analysis of the NEP markets.

The factors that had the most influence on relative export performance differed between the NEP and MEP market segments. The following tabulation presents the significant factors and their influence in determining U.S. export performance relative to the other MEP countries in each market.

NEP Markets

Rank	Factor
1	Exchange rates
2	Capital formation
3	R&D expenditures

MEP Markets

Rank	Factor
1	Openness index
2	R&D scientists and engineers
3	R&D expenditures

In both the NEP and MEP market segments, the factor that had the most influence in determining U.S. export performance has been external to the communications equipment industry. Of the internal factors, R&D-related factors have been important in explaining U.S. export performance relative to that of the other MEP countries.

The most influential factor for the NEP markets was the exchange rate, whereas the openness index was the most influential factor for the MEP markets. These results most likely reflect two characteristics of the markets: the demand for different products in each market and the nature of the competitive environment in each market. Exchange rates appear to be more important for the NEP markets because the products that the United States and the other MEP countries sell in these markets are more likely to be responsive to price, such as terminal equipment.[3] Also, exchange rates are likely to capture the impact of relative price movements on the trade flows from the MEP countries to the NEP countries. The United States and the other

[1] Other factors that could not be quantified were industrial policies discussed in chapter 4 and firm structure and market alliances discussed in chapter 5.

[2] The terms "significant" and "significance" in this chapter mean statistically significant, which implies that there is a relatively small chance, for example, 10 or less in 100, that these factors do not have any impact on the international competitiveness of the communications equipment industry.

[3] It should be noted that the impact of exchange rates on communications equipment exports is not unique to this industry. Exchange rates will have a similar impact on exports of other price-responsive sectors in an economy.

MEP countries are thus more likely to compete on the basis of price in NEP markets.

Exchange rates did not appear to be important for the other MEP markets but the openness index did. This most likely demonstrates the impact of procurement policies and the resulting embedded base in the other MEP countries which have resulted in limiting access to these markets. Chapters 2 and 4 discussed how these policies have tended to create relatively closed markets for communications equipment. Hence, it is likely that competitiveness is more influenced by price in the NEP markets and by nonprice factors, such as procurement policies, embedded base, and technology, in the MEP markets. Therefore, the significant results obtained for the MEP markets indicated that the degree of accessibility of these markets as well as the industry's innovative potential seem to be important factors in explaining U.S. competitiveness in the communications equipment industry in the MEP markets.

It should be noted that the impact of such factors as tied aid, export controls, regulation, and market-penetration efforts on relative export performance could not be quantified. However, chapters 4 and 5 have discussed the importance of these factors in determining U.S. export performance relative to the other MEP countries in the NEP and MEP markets. The quantitative results presented in this chapter should be interpreted accordingly.

Methodology

The methodology used to assess the global competitiveness of the U.S. communications equipment industry consisted of three basic steps. The first step was to select indexes to represent export performance. These indexes compare the export shares held by the United States and the other MEP countries in the NEP and MEP market segments. The second step was to quantify the external and internal factors that most likely determined relative export performance. This step involved computing ratios of the values for the other MEP countries to the corresponding values for the United States for each factor. Such a comparative assessment is appropriate because trends in external and internal factors in the other MEP countries relative to the United States will influence the competitiveness of the U.S. communications equipment industry. The third step was to estimate the significance and relative influence of these factors on the export performance of the United States in comparison to the other MEP countries in NEP and MEP market segments.

The quantitative impact of the external and internal factors was estimated using aggregate data for all communications equipment because the product-based data were not available. A qualitative assessment as to the likely influence of the selected factors on the different segments of the industry is presented below. The Commission ranked the external and internal factors according to their expected influence on the terminal, transmission, and switching equipment segments of the industry. This scheme was developed by the Commission after evaluating the information gathered from the literature and from interviews with industry representatives in the United States, Europe, and the Far East. The beta weights provided by the regression analysis were compared to the suggested ranking scheme for the quantifiable external and internal factors selected for the NEP and MEP market analyses.

Information used to quantify the measures of competitiveness and the external and internal factors at the aggregate level was obtained from OECD, International Monetary Fund, and United Nations data bases. The sample period was 1970-89; however, not all countries reported the needed data for all years. Accordingly, the actual period used varies with the availability of data for both the NEP and MEP countries. Further, since firm-level data were not available, relative export performance is assessed at the country level only.

The following sections present results for the analyses of the NEP and MEP market segments. Also described are the measures and determinants selected to analyze U.S. competitiveness in international communications equipment markets.

Nonmajor Equipment-Producing Markets

Measures Of Competitiveness

The measure of U.S. competitiveness used for the NEP markets compares the export performance of the United States to that of another MEP country in a given NEP market. It is as follows:

$$\frac{\text{Exports from MEP country i to NEP market k}}{\text{United States exports to NEP market k}}$$

where MEP country i = Canada, Germany, Sweden, United Kingdom, etc.

NEP market k = Australia, Brazil, Greece, Venezuela, etc.

In order to control for differences in competitors, regressions were run with the data for all the other MEP countries pooled[4] and for each MEP country individually. Similarly, in order to control for differences in markets, regressions were run with the data for all the NEP markets pooled and for each NEP market individually.

[4] When the data are pooled, all observations for the countries of interest are combined in a single regression. For example, when the data for the MEP countries are pooled to estimate relative export performance in the Australian market, the data set would include all the observations on U.S. export performance relative to Canada, France, Germany, and so forth, for the Australian market. The data for each country's relative performance are included as separate observations, but all of the observations are combined in a single regression. When separate regressions are done for each individual country, only those observations relating to a particular country's relative export performance are included in each regression.

Determinants Of Competitiveness

Five quantifiable factors were used to assess the international competitiveness of the U.S. communications equipment industry. They are listed in figure 6-2. These factors attempt to capture two important characteristics of the global communications equipment industry—the industry's cost structure and the industry's innovative potential. The industry's cost structure, as measured by labor and manufacturing costs, represents an MEP country's comparative advantage in the production of communications equipment. The industry's innovative potential, as measured by its R&D expenditures and its level of technical expertise, reflects the dynamic attributes of its competitiveness.

The expected impact of the selected factors is different for the three major product categories within the communications equipment industry. Figure 6-2 ranks the external and internal factors, suggesting how influential these factors may have been in determining relative export performance for each product line. For example, exchange rates, and costs associated with labor and manufacturing are more influential in determining international competitiveness for the terminal equipment segment than for other product segments of the industry. As discussed in chapter 3, most terminal equipment is based on technology that is simpler than that employed in the transmission and switching equipment segments of the industry. Accordingly, terminal equipment is fairly standardized and lends itself to mass production techniques. Hence, costs of production become more critical in explaining the international competitiveness of this segment of the communications equipment industry. Also, the terminal equipment segment of the industry tends to be more responsive to exchange rate fluctuations than the transmission and switching equipment segments of the industry.[5]

In contrast, internal factors, such as the level of technical expertise and R&D expenditures, are more important for determining international competitiveness in the transmission and switching equipment segments of the industry. As discussed in chapter 3, these products are associated with more sophisticated technology and their sales depend more on the customization requirements of purchasers. Therefore, purchases of these products tend to depend more on customer specifications and less on price.

Finally, figure 6-2 presents the measures used in this analysis to quantify each of the determinants of relative export performance. As shown in this figure, ratios will be used to compare the impact of the selected factors on relative export performance. It is expected that exchange rates will have a positive impact on relative export performance, so that an appreciation of the dollar relative to another major equipment producer's currency will improve that producer's export performance relative to the United States. Similarly, an increase in one of the internal factors, such as R&D expenditures or the level of technical expertise, in another MEP country relative to that in the United States will improve the export

[5] Robert W. Crandall, *After the Breakup: U.S. Telecommunications in a More Competitive Era*, Washington, DC: The Brookings Institution, 1991, p. 100 and 102.

Figure 6-2
Determinants of relative export performance in NEP markets

Determinants		Type of Equipment[1]				Measurement of Determinants
		Terminal	Transmission	Switching	Total Equipment	
External To The Firm	Labor Costs	3	4	4	4	Ratio of Real Wage Rates
	Exchange Rates	2	5	5	5	Foreign Exchange Rate Relative of US Dollar
Internal To The Firm	Level of Technical Expertise	5	2	2	2	Ratio of R&D Scientists and Engineers
	R&D Expenditures	4	1	1	1	Ratio of Real R&D Expenditures
	Manufacturing Techniques	1	3	3	3	Ratio of Real Gross Fixed Capital Formation

[1] The ranking is as follows: 1 = most influential. 5 = least influential.

Source: Staff of the U.S. International Trade Commission

performance of that MEP country relative to the United States. Labor costs are expected to have a negative impact as an increase in the wage rate in a given MEP country relative to the U.S. wage rate is expected to diminish its export performance relative to the United States.

The discussion below presents a comparative assessment of the external and internal factors that most likely explain the export performance of equipment producers. The data illustrated in the figures below were used to compute the ratios of values associated with each of the external and internal factors for each of the other MEP countries relative to the corresponding U.S. values.

External Factors

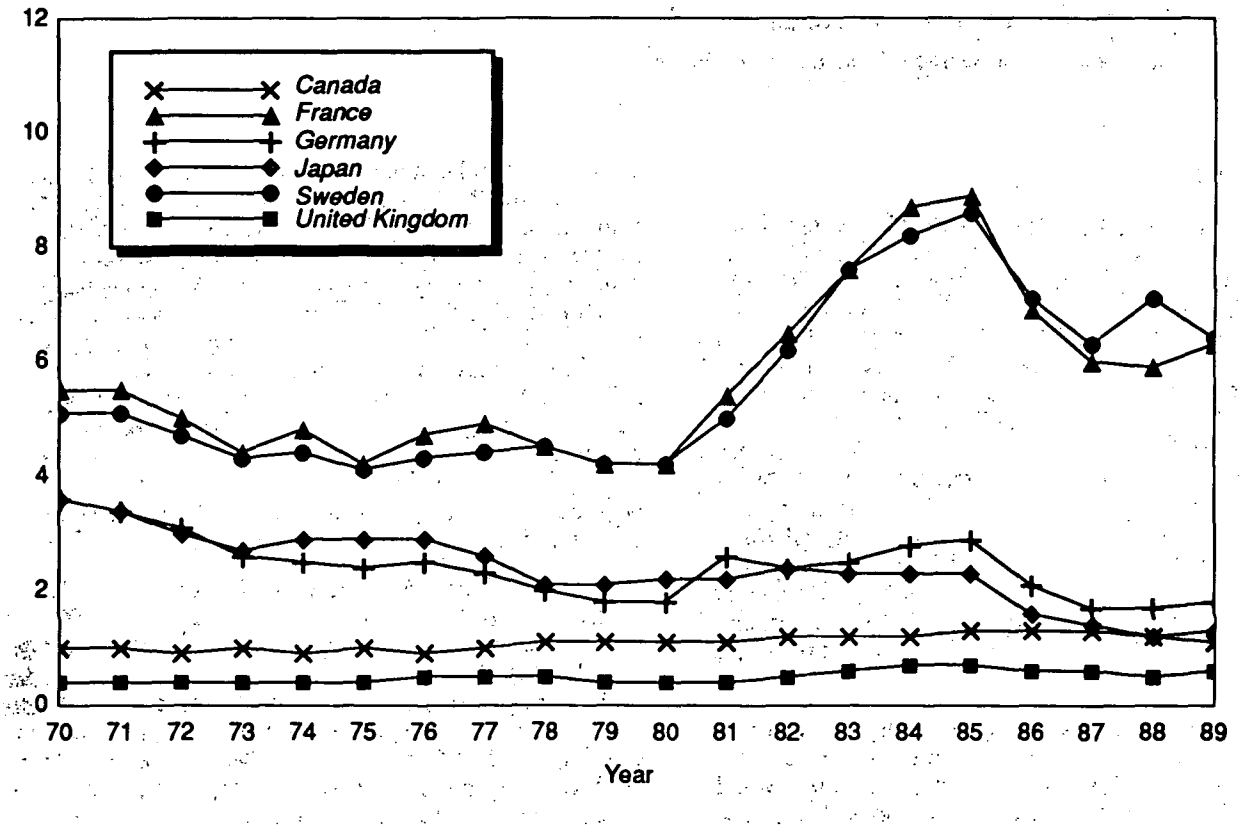
This section summarizes trends associated with exchange rates and annual wages for the United States and the other MEP countries.

Data on exchange rates are presented in figure 6-3. The British pound and the Canadian dollar remained relatively stable against the U.S. dollar during the period. In contrast, the French franc and the Swedish kroner fluctuated substantially during 1980-89. The Japanese yen and the German mark have generally appreciated relative to the U.S. dollar over 1970-89. General economic conditions in the other MEP countries are the likely reason for the instability in the exchange rate. The Plaza Accord may also explain the decline in the value of the U.S. dollar after 1985.[6]

Figure 6-4 shows the trends in the annual wages per employee, in 1985 constant U.S. dollars, for the other MEP countries and the United States. Annual wages per employee are expected to capture relative labor costs. As shown in figure 6-4, annual wages in the United States remained higher than those in the other MEP countries for the entire period, though they were followed closely by Swedish and Canadian annual wages. Japanese and British wages seemed to have had similar trends but were lower than the wages in the other MEP countries. Wages across all the MEP countries experienced an upward trend in the later years of the period. The annual wage data presented in figure 6-4 for each country have been deflated by the country-specific wholesale price deflator and then converted into constant U.S. dollars using the 1985 exchange rate. Data for annual wages for France were not available.

[6] "Talking the dollar down," *The Economist*, September 28, 1985, p 15 and 16.

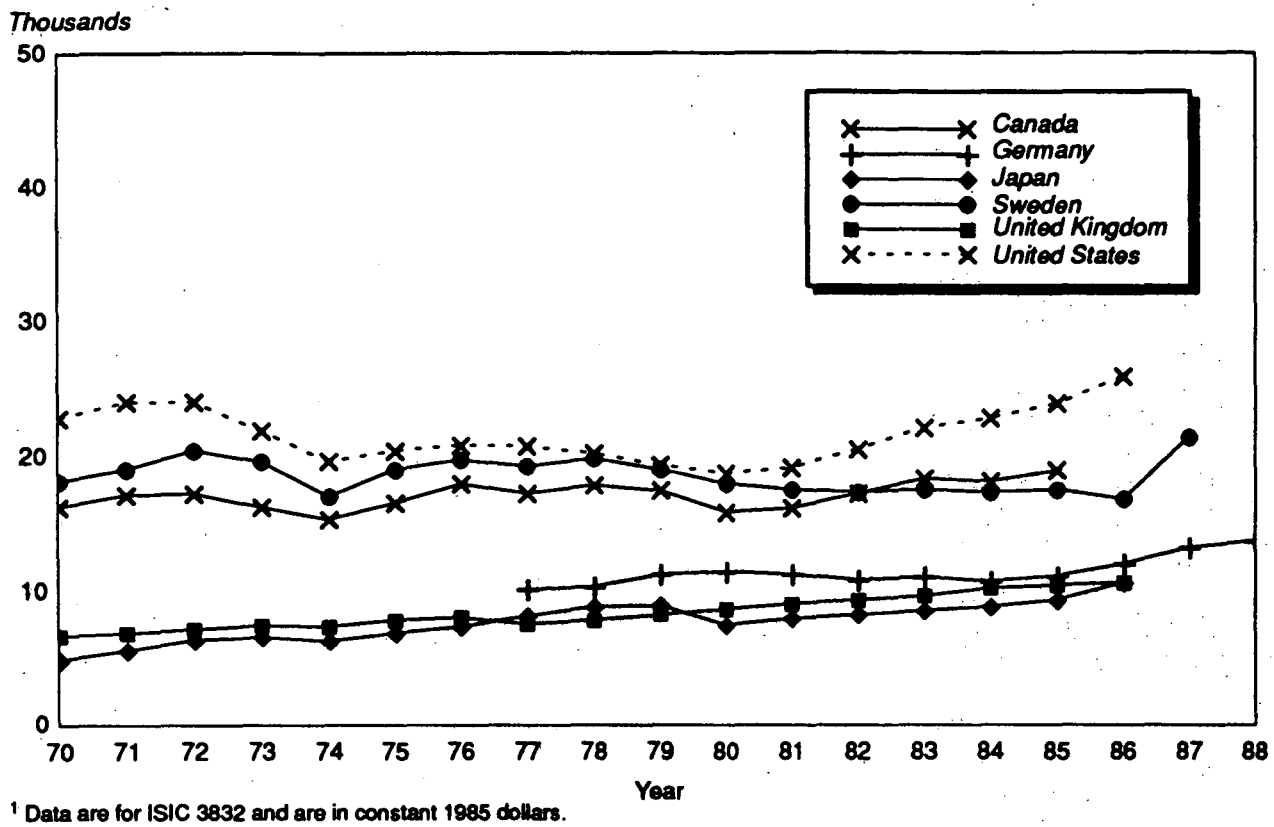
Figure 6-3
Exchange rates in foreign currency units per dollar for selected countries, 1970-89



Note.—Japan's values are divided by 100.

Source: International Monetary Fund, *International Financial Statistics*, Series rf, NIH Computer Center.

Figure 6-4
Annual wages per employee in the communications equipment and semiconductor industries in selected countries, 1970-88[1]



[1] Data are for ISIC 3832 and are in constant 1985 dollars.

Source: OECD Directorate of Science, Technology and Industry.

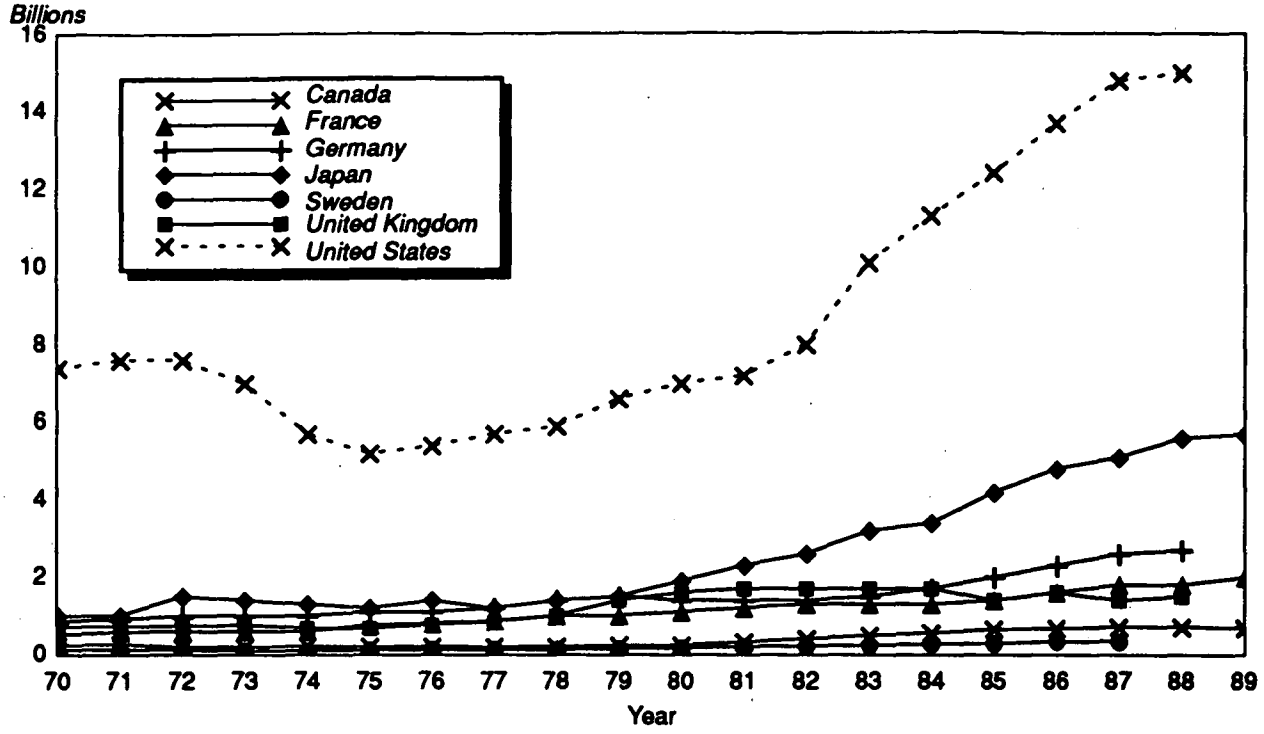
Internal Factors

Figure 6-5 shows the trend in R&D expenditures for the electronics industry, which included the communications equipment industry, in the MEP countries during the period. Except for the United States and Japan, R&D expenditures in the MEP countries have remained relatively constant for most of this period. As was discussed in chapters 4 and 5, the increase in Japanese R&D expenditures in the mid-1980s was due in part to the creation of several support facilities for basic research by the Japanese government during that period. The increase in U.S. industrial R&D expenditures during the mid-1970s to the mid-1980s may have been partially due to increased investment in new technologies. Further, as discussed in chapter 4, defense-related R&D expenditures may also explain the increase in R&D expenditures during most of the 1980s.

Gross fixed capital formation, presented in figure 6-6, includes spending on land, buildings, machinery, and equipment for the electronics industry which includes the communications equipment industry. Capital expenditures are expected to capture the level of investment related to manufacturing techniques used by the MEP countries in the production of communications equipment. This factor is expected to reflect attempts made by equipment producers to enhance their ability to manufacture communications equipment in an efficient and timely fashion. As shown in figure 6-6, gross fixed capital formation for the United States was substantially higher than in other MEP countries. Gross fixed capital formation appeared relatively constant for the rest of the major equipment producers for the period under consideration. The values for gross fixed capital formation were converted into real U.S. dollar terms in the same way as annual wages. Swedish data were unavailable.

Finally, figure 6-7 presents the trends in the number of R&D scientists and engineers per 10,000 workers in the electrical equipment industry, which includes the communications equipment industry, in each country. This factor is expected to capture the level of technical expertise in the communications equipment industry in each of the MEP countries. In general, it appears that all these countries experienced an increase in the number of scientists and engineers per 10,000 workers over the period.

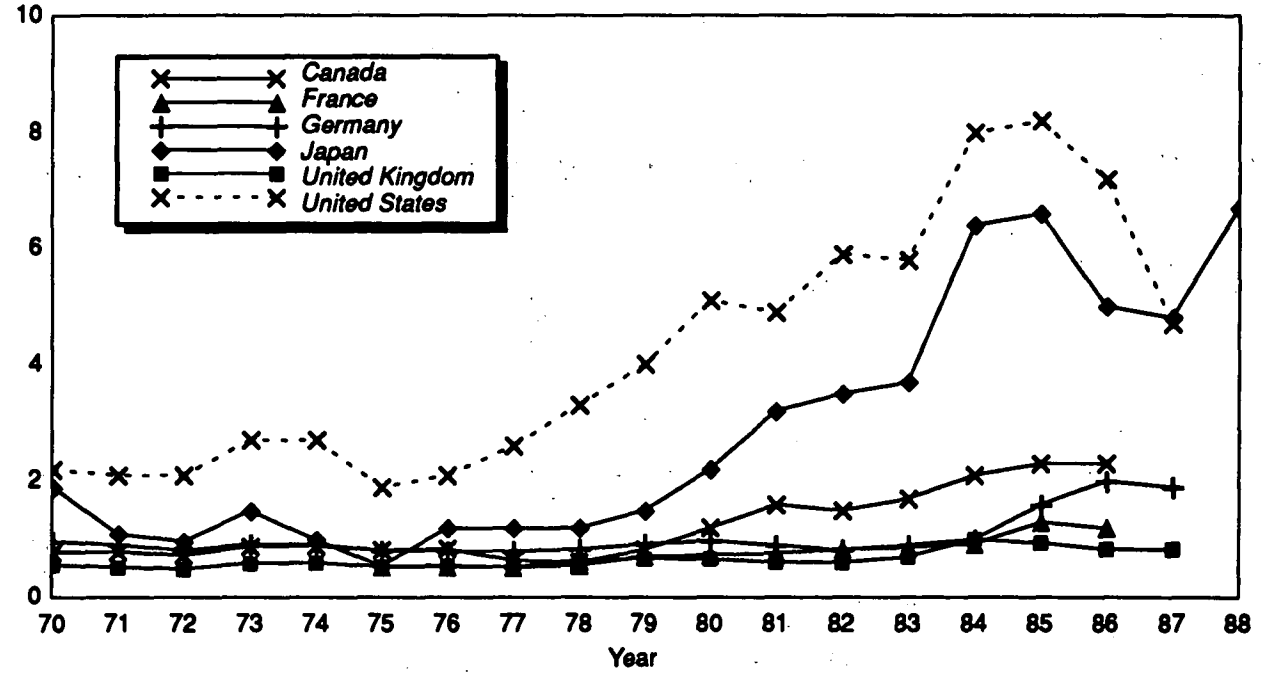
Figure 6-5
R&D expenditures in the communications equipment and semiconductor industries in selected countries, 1970-89[1]



[1] Data are for ISIC 3832 and are in constant 1985 dollars.

Source: OECD Directorate of Science, Technology and Industry.

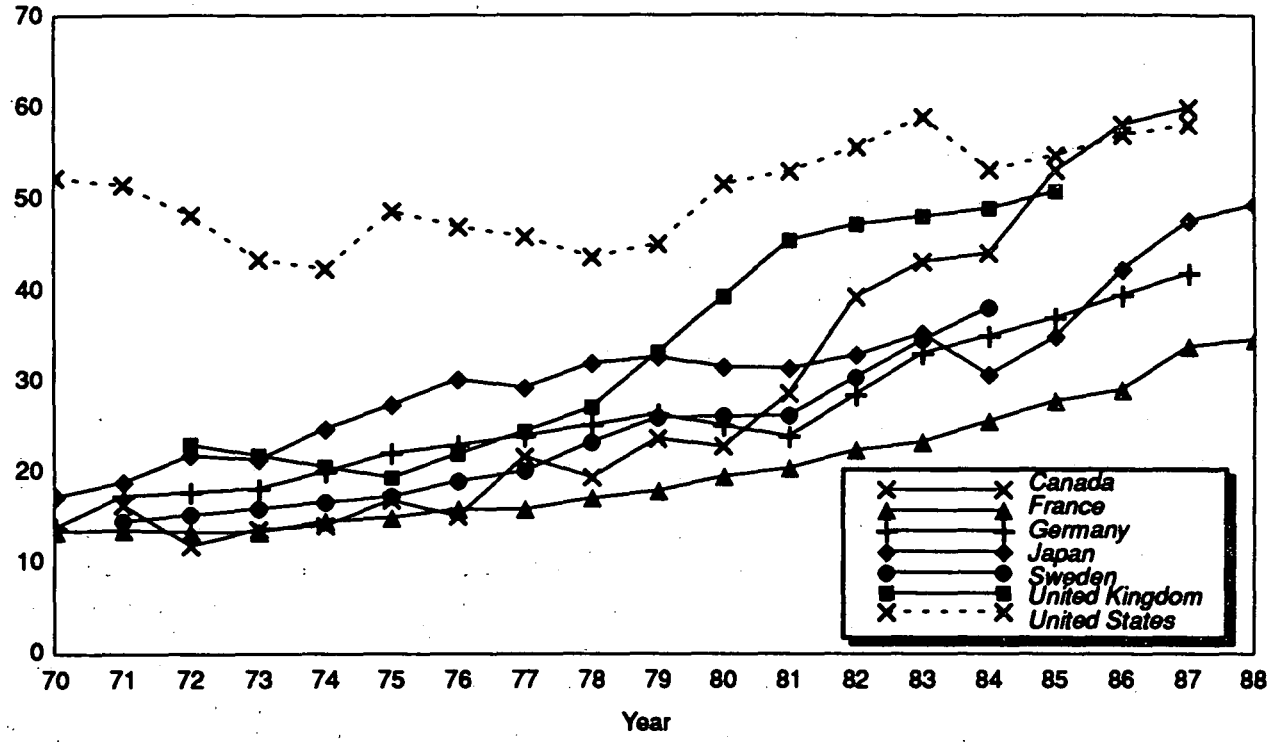
Figure 6-6
Gross fixed capital formation in the communications equipment and semiconductor industries in selected countries, 1970-88[1]



[1] Data are for ISIC 3832 and are in constant 1985 dollars.

Source: OECD Directorate of Science, Technology and Industry.

Figure 6-7
R&D scientists and engineers per 10,000 workers in the electrical machinery industry in selected countries, 1970-88[1]



[1] Data are for ISIC 383.
Source: OECD Directorate of Science, Technology and Industry.

The next section presents the results of the regression analysis which estimated the impact of the external and internal factors on U.S. export performance relative to the other MEP countries in the NEP markets.

Summary of Results for Nonmajor Equipment-Producing Markets

The factors and their expected impact for the NEP markets are as follows:

Factors	Expected Impact
Relative wages	Negative
Exchange rate relative to U.S. dollar	Positive
Relative number of scientists and engineers	Positive
Relative R&D expenditures	Positive
Relative gross fixed capital formation	Positive

As mentioned earlier, the export performance of the United States relative to the other MEP countries was estimated in four ways. For the significant results obtained for these four estimations, the determinants of competitiveness identified by the Commission appear to explain between 40 and 90 percent of the variation[7] in relative export performance. The results indicate that exchange rates were both significant and the most influential factor in explaining relative export performance. This finding differs from what was expected (see figure 6-2), but, as explained below, it could reflect the influence of the more price-responsive segments of the industry on the aggregate data. In addition, exchange rates may be capturing the impact of relative price movements on the trade flows from the other MEP countries and the United States to the NEP countries. Capital formation appears to be the second most influential factor in determining international competitiveness followed by R&D expenditures. Again, the order of influence is different from what was expected, since R&D is considered essential to maintaining competitiveness according to industry sources, as noted in chapter 3. A possible explanation

[7] This refers to the value of the adjusted R-squared from the regression equation. R-squared is the proportion of the variation in relative export performance that can be attributed to the external and internal factors selected in this study. R-squared is adjusted to reflect the total number of factors being considered in the analysis.

of this ordering is that while R&D is needed for the development of new products, capital expenditures are needed to maintain and expand the existing plant and equipment that is manufacturing the current generation of products. Since current sales provide the funding for all investment, both capital formation and R&D, industry managers may favor investments, such as capital formation, that maintain the revenue base. Further, capital formation may also reflect the investment in state-of-the-art manufacturing techniques required to commercialize new R&D developments.

One overall result for the NEP countries appears to be that the market an equipment producer is selling into matters more than the competitor the producer is facing. This result indicates that individual markets are also a factor in explaining relative export performance. As shown below, this conclusion is supported by a comparison of the performance of the United States with that of all the other MEP countries in each NEP market and a comparison of the performance of the United States with that of each of the other MEP countries in all NEP markets. One likely reason, as was discussed in chapter 2, is that historical relationships, such as colonial ties, between the NEP countries and certain MEP countries may have influenced the purchase of communications equipment by the NEP countries. A detailed review of the results for each estimation follows.

Estimation 1

The first to comparison of U.S. export performance relative to the other MEP countries pooled all the data for the other MEP competitors and NEP markets. In this estimation, the external and internal factors explained about 45 percent of the variation in the relative export performance.

Capital formation, R&D expenditures, and exchange rates were the factors which were significant and had the expected positive impact in explaining relative export performance. Exchange rates appear to be the most influential factor followed by capital formation and R&D expenditures, in that order, contrary to the expected ranking shown in figure 6-2. As mentioned earlier, these results likely capture the influence of exchange rates on the more price-responsive terminal equipment segment of the industry as well as the impact of relative price movements on general trade flows from the MEP countries to the NEP countries.

Estimation 2

The estimated impact of the external and internal factors on U.S. export performance relative to all of the other MEP countries in each individual NEP market indicates that one or more factors are significant in each NEP market. For this estimation, the data were pooled for the other MEP countries relative to the United States. The pooled data were then used to run 16 regressions, one for each NEP market. For the comparisons made for the 16 NEP markets, the results were as follows: (1) exchange rates were significant in 12 markets; (2) relative R&D expenditures were significant in 6 markets; and (3) relative annual wages, relative capital formation, and the relative number of scientists and engineers were each significant in 5 markets. The results for these comparisons explained 43 to 93 percent of the variation in the relative export performance.

Figure 6-8 presents the relative influence of these significant factors for the individual NEP markets. The ranking of factors for each of the NEP countries indicated in figure 6-8 was provided by the beta weight estimates obtained from the regression analysis. These beta weight estimates indicate the relative influences of the significant factors on the relative export performance of the United States versus the other major equipment-producers in each of the NEP markets. For example, in the case of the Australian market, the factor which is most influential on relative export performance is capital formation. The other factors, such as exchange rates and the level of technical expertise, are also important but less influential on the export performance of the United States relative to other MEP countries in the Australian market. A similar interpretation applies to the beta weight estimates associated with the factors for each of the other NEP markets.

As seen in figure 6-8, exchange rates appear to be the most influential factor in 6 of the 12 markets where it was significant. R&D expenditures were the most influential in 5 of the 6 markets where they were significant, and capital formation was the most influential in 3 out of the 5 markets where it was significant. Relative annual wages appeared to be less influential than exchange rates and R&D expenditures. Further, the relative number of scientists and engineers was significant in only 5 of the regressions and, in each of these cases was the least influential of the significant factors. This may imply that labor costs and the level of technical expertise are less important to the export performance of the United States relative to the other major equipment-producers in the individual NEP markets.

The expected impact listed in figure 6-8 corresponds to the estimated impact for labor costs, but does not correspond to the estimated impact for technical expertise. The significance of R&D expenditures may mask the impact of technical expertise, though, since these factors experienced similar growth trends during the period.[8] Also, the rankings suggested in figure 6-2 for exchange rates and capital formation indicated that these factors may be less influential for total communications equipment as a whole but more influential for the terminal equipment segment of the industry. The estimated relative influence noted in figure 6-8 may again be capturing the terminal equipment segment of the industry for

[8] This result may imply that R&D expenditures and technical expertise are related to each other in a statistical sense, but the degree of this relation is not expected to degrade the estimate of their individual contribution. See Appendix G.

Figure 6-8
Relative influence of the significant factors affecting U.S. competitiveness versus the other MEP countries in individual NEP markets[1]

NEP MARKET	External Factors		Internal Factors		
	Relative Wage Rates	Exchange Rates	Relative Capital Formation	Relative R&D Expenditure	Relative Number of Scientists and Engineers
Australia		2	1		3
Brazil		1			2
Greece				1	
Indonesia	3	2		1	
Jordan	2			1	3
Korea		1			
Malaysia		2	1		
Mexico		1			
New Zealand			1		2
Philippines		1		2	
Poland	1				
Saudi Arabia	2	3		1	
Spain	3	2		1	
Thailand		1	2		3
Turkey		2			
Venezuela		1	2		

[1] Relative influence refers to the beta weights estimated for the factors.

Note.—The data for the other MEP countries were pooled for the regressions that generated the results presented in this table.

Source: Staff of the U.S. International Trade Commission.

which manufacturing techniques and exchange rates are important in explaining relative export performance. As noted above, exchange rates may be capturing the impact of relative price movements on the trade flows.

Estimation 3

For this estimation, the export performance of the United States was compared to that of each MEP competitor in each NEP market. This examination resulted in a total of 96 regressions. Of this total, about 70 percent yielded significant results. For those comparisons with significant results, the external and internal factors most often explained 50 to 60 percent of the variation in export performance.

Figure 6-9 indicates the number of times that each factor has been significant in explaining U.S. export performance relative to another MEP country, regardless of the importing NEP market. The numbers in figure 6-9 are an indication of the competitive strength of the United States relative to each of the other MEP countries for a given factor rather than a ranking of relative influence as was the case in figure 6-8.

For Canada, each factor was significant in explaining its performance relative to the United States in at least one NEP market. As shown in figure 6-9, manufacturing techniques, as proxied by capital formation, and exchange rates were the factors which were most significant for Canada. For France, capital formation appears to be the primary explanation of the country's performance relative to the United States

while the remaining factors seem to have had less impact on its export performance.

All factors were significant in explaining Germany's competitiveness in at least one NEP market for communications equipment. Capital formation appears as a significant factor more frequently than R&D expenditures and the relative number of R&D scientists and engineers. Annual wages and exchange rates are a significant factor an equal number of times.

For Japan, the level of technical expertise, as measured by the relative number of scientists and engineers, was the factor that was most often significant. For Sweden, exchange rates appeared to be a significant factor most frequently. For the United Kingdom, all factors except R&D expenditures appeared to be significant an equal number of times. Notably, it is only in the United Kingdom that the relative number of scientists and engineers was ranked as highly as the other significant factors. As mentioned in chapter 5, one possible reason for this ranking is that the United Kingdom is a leader in software expertise.

In general, relative comparative advantage, as reflected by the costs of production (the annual wages and gross fixed capital-formation factors), and exchange rates appear to be the most important factors determining international competitiveness in the NEP markets. R&D expenditures and the number of R&D scientists and engineers seem to have less power in explaining relative export performance in these markets.

Estimation 4

For this estimation, the data for the NEP countries were pooled. The pooled data were then used to run 6 regressions in order to assess U.S. export performance relative to each of the other major equipment-producers. This estimation did not provide any significant results. This may imply that the external and internal factors do not alone explain the differences in export performance. It appears that the characteristics of the individual NEP markets are an important factor in explaining the export performance of individual competitors that is not revealed when these markets are grouped together. For example, as discussed in chapter 2, historical ties, such as those between a MEP country and its former colonies, may also influence the purchase of communications equipment in the NEP markets. Thus, characteristics in the individual NEP markets also appear to be influential in determining the international competitiveness of the MEP countries in the communications equipment market.

Major Equipment-Producing Markets

Measures Of Competitiveness

Two measures of competitiveness were employed to examine U.S. competitiveness in the other MEP markets. This was done in an attempt to capture different aspects of U.S. competitiveness.

The first measure of competitiveness is analogous to the one used for the NEP market analysis. It measures U.S. export performance relative to each MEP country in a third MEP market. This measure reflects head-to-head competition between the two equipment-producing countries in a given MEP market. For example, in the case of competition between the United States and Canada in the German market, the measure is computed as follows:

Figure 6-9
Frequency of significant factors affecting competition between the United States and individual MEP countries in individual NEP markets[1]

	External Factors		Internal Factors		
MEP Country	Relative Wage Rate	Exchange Rate	Relative Capital Formation	Relative R&D Expenditure	Relative Number of Scientists and Engineers
Canada	2	3	3	1	1
France		1	3	1	1
Germany	2	2	4	1	1
Japan	3		2		7
Sweden	2	3		1	2
United Kingdom	2	2	2		2

[1]The numbers in this figure represent how often a particular factor was significant for a given MEP country regardless of the NEP market. They do not indicate relative influence of these factors as they did in figure 6-8.

Source: Staff of the U.S. International Trade Commission.

Measure 1

$$\frac{\text{Canadian communications equipment exports to Germany}}{\text{U.S. communications equipment exports to Germany}}$$

This measure is similarly computed for the other MEP countries relative to the United States for a given third MEP market.

The second measure is the ratio of U.S. exports of communications equipment to a given MEP market to total U.S. exports of communications equipment to all markets. This measure reflects how U.S. equipment producers have performed given the competition they face from the domestic suppliers in a given MEP market.[9] As discussed in chapters 3 and 4, procurement policies and the resulting embedded base in the purchaser country affect the ability of a supplier to penetrate the market of the purchaser country, particularly when the service provider is affiliated with the government. Also, policies such as buy-national programs and sole-sourcing can keep preferred national suppliers well financed and unchallenged in their home markets. Changes in procurement policies will thus influence how much is imported from other countries. The second measure with respect to Canada, for example, was computed as follows:

Measure 2

$$\frac{\text{U.S. communications equipment exports to Canada}}{\text{Total U.S. communications exports to the World}}$$

This measure was similarly computed for the U.S. export share to the other five MEP countries. The trends for this measure were illustrated in figure 6-1.

Determinants Of Competitiveness

Figure 6-10 indicates the six external and internal factors that most likely determine U.S. export performance in the other MEP markets for three major product categories in the industry. The internal factors for the MEP markets are the same as for the NEP markets. Therefore, the factors that affect the U.S industry's efforts to export and that are under its control do not appear to change for different markets. That is, the industry's cost structure and innovative potential remain the same regardless of where it sells its products. However, the difference between the MEP markets and the NEP markets lies in the additional external factor—the degree of market access in the MEP markets. This factor is particularly relevant for the MEP markets due to the existence of procurement policies and the resulting embedded base in these markets which determine how receptive or open they are to imports of communications equipment. It should be noted that the impact of this factor should not differ when relative export performance is considered as a measure of competitiveness because, in general, two competing MEP countries are expected to face similar procurement policies in a given third MEP market. An openness index is developed as a proxy for procurement policies and the resulting embedded base and is described in greater detail below. Further, except for the computation methodology for the openness index provided below, the trends and data for the internal and other external factors are the same as for the NEP market analysis and have been discussed earlier.

Figure 6-10 also suggests a ranking for the external and internal factors indicating which factor may be more influential in determining the export performance for each type of product in the other MEP markets. This scheme, similar to that in figure 6-2 for the NEP markets, is based on the evaluation of the views of industry analysts and representatives. According to this ranking scheme, external factors, such as procurement policies, are expected to influence the export performance in every segment of the industry. Of the internal factors, R&D expenditures and the level of technical expertise are expected to influence relative export performance more than manufacturing techniques for transmission and switching equipment segments. Labor costs, on the other hand, appear to be more influential in the terminal equipment segment of the industry. As before, this suggested ranking scheme will be compared with the ranking as estimated by beta weights for the selected external and internal factors.

Figure 6-10 presents the measures used in this analysis to quantify each of the determinants of export performance for producers in the MEP markets. As was the case with the NEP markets, the internal factors are expected to have positive influence on U.S. export performance relative to the other MEP countries. For the external factors, a relative rise in labor costs in an MEP country, increased regulation in an MEP market, and a devaluation of the U.S. dollar are expected to adversely affect an MEP country's export performance relative to the United States.

An openness index for the MEP countries was developed to encompass the impact of various government policies on export performance. This index attempts to measure how easy it is for an equipment producer to penetrate a given MEP market. The more open an MEP market is, the easier it is for any MEP country to export to that market. Hence, the impact of the openness index on export performance of the MEP countries is expected to be positive. The first measure of competitiveness tested for the significance of openness in explaining the export performance of each MEP country relative to the United States in a third MEP market. The second measure of competitiveness tested for head-to-head competition

[9] Due to data limitations, market share, one of the standard measures of competitiveness, has not been considered in this study.

Figure 6-10
Determinants of relative export performance in the MEP markets

Determinants		Type of Equipment[1]				Measurement of Determinants
		Terminal	Transmission	Switching	Total Equipment	
External to the Firm	Procurement Policies	4	1	1	1	$\frac{\frac{MEP_i\ COMM.\ IMPORTS\ (M)}{TOTAL\ MEP_i\ MS}}{\frac{Total\ MEP\ COMM.\ MS}{TOTAL\ MEP\ MS}}$
	Labor Costs	3	5	5	5	Ratio of Real Wage Rates
	Exchange Rates	2	6	6	6	Foreign Exchange Rate Relative to the U.S. Dollar
Internal to the Firm	Level of Technical Expertise	6	3	3	3	Ratio of R&D Scientists and Engineers
	R&D Expenditures	5	2	2	2	Ratio of Real R&D Expenditures
	Manufacturing Techniques	1	4	4	4	Ratio of Real Gross Fixed Capital Formation

[1] The ranking is as follows: 1 = most influential. 6 = least influential.
Source: Staff of the U.S. International Trade Commission

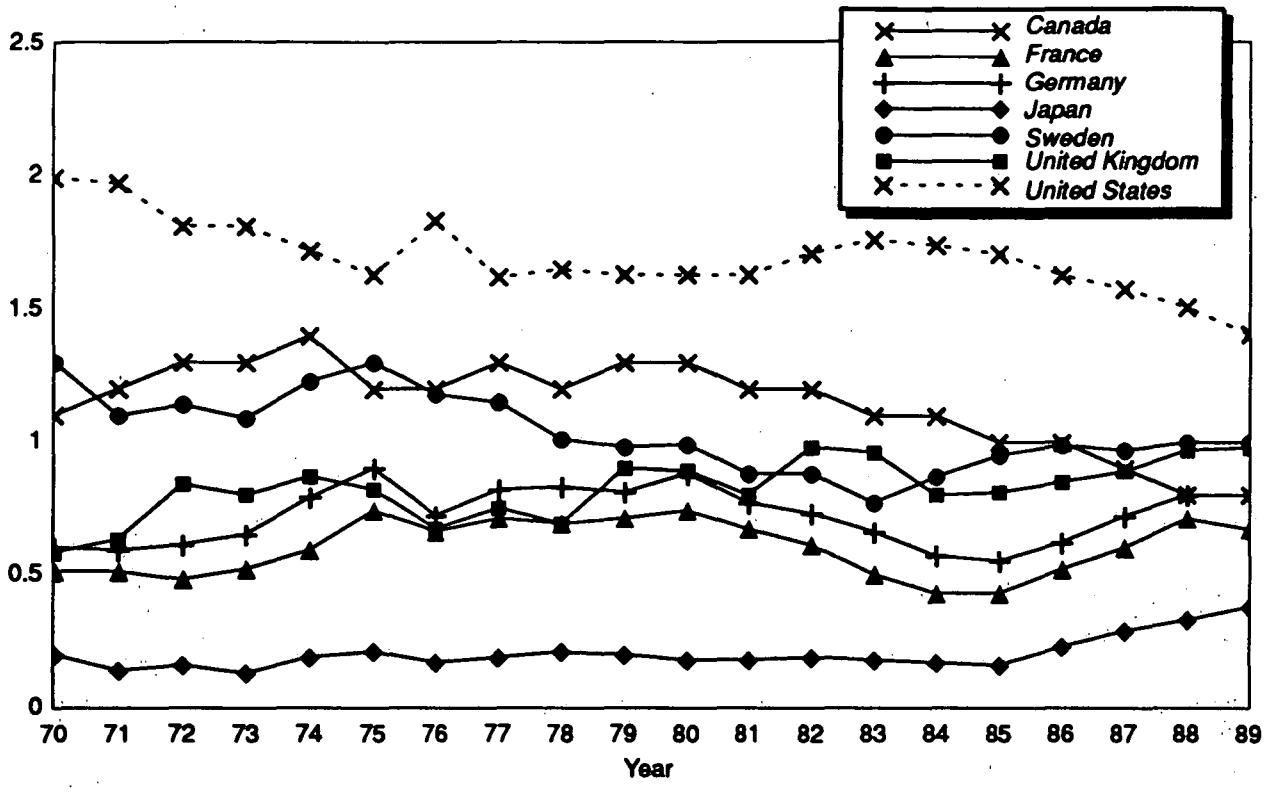
between U.S. producers and domestic suppliers in a given MEP market. The openness index is expected to be significant and most influential in the second measure in explaining U.S. export performance in the other MEP markets.

The government policies which the openness index attempts to capture are procurement policies in the other MEP countries. As was shown in chapters 4 and 5, the bias towards buying from domestic producers and local standards existing in some MEP countries have led to an embedded base in these countries, thereby making it difficult to penetrate these markets.[10]

[10] The openness index is used to capture procurement policies collectively as a suitable measure for each specific policy is not available.

Hence, it is expected that the impact of the embedded base is also being reflected in the openness index computed for each MEP country. Figure 6-11 shows the trend for the openness index for the United States and the other MEP countries considered in the study. The index is calculated by comparing the ratio of imports of communications equipment to total imports for an individual MEP country to the ratio of imports of communications equipment for all seven countries to total imports for all seven countries. Figure 6-11 shows that the U.S. market for communications equipment has been more accessible than the markets of the other MEP countries during the period. The Japanese market was the least open to imports of communications equipment. However, as discussed in chapters 2, 4, and 5, access to the Japanese market began to increase after 1985, with liberalization of

Figure 6-11
Openness Index for telecommunications apparatus in selected countries, 1970-89[1]



[1] Group 724, SITC, Revised.
Source: United Nations Online Trade Database, NIH Computer Center.

telecommunications services in Japan, the privatization of Nippon Telegraph and Telephone (NTT), the MOSS trade talks that took place in that year, and recent concessions as a result of U.S. pressure associated with the Trade Act of 1988. As was shown in figure 6-1, the percentage of U.S. communications equipment exports destined for Japan increased over the 1985-1989 period, with a sharper increase during the 1988-89 period.

The results for the two measures of U.S. competitiveness relative to the other MEP markets are presented below. Each of these measures of competitiveness was tested against the same external and internal factors. A summary of the results obtained for the two measures is presented below followed by the detailed results.

Summary of Results for Major Equipment-Producing Markets

Two measures of competitiveness were used to analyze several aspects of competition between the United States and the other MEP countries in the communications equipment market. The first measure, similar to that used for the NEP markets, depicted relative export performance. For this measure, the industry's innovative potential, reflected by R&D expenditures and the number of scientists and engineers, was significant in explaining U.S. export performance relative to that of the other MEP countries. The first measure explained up to 90 percent of the variation in relative export performance.

The second measure of competitiveness also explained up to 90 percent of the variation in export performance. When the data for the other MEP countries were pooled, the openness index, R&D expenditures, and annual wages were significant. The openness index was the most influential factor. When the other MEP markets were examined individually, fewer of the external and internal factors were significant. However, the level of technical expertise, reflected by the number of R&D scientists and engineers, was significant and affected U.S. export performance as expected. The openness index did not perform as well in explaining the U.S. export performance when the other MEP countries were analyzed individually. The lack of significance of the openness index is likely due to the fact that the impact of specific policies is not adequately captured by the openness index. As was noted earlier, the lack of necessary data on specific procurement policies precluded the estimation of the impact of these policies on an individual basis.

The significant results obtained for the other MEP markets indicate that the degree of accessibility of the other MEP markets as well as the industry's innovative potential seem to be important factors in explaining U.S. competitiveness in these markets. It should be noted that the lack of necessary data for market penetration efforts precluded estimating the impact of this factor on U.S. competitiveness, and the results provided by the regression analysis in this chapter need to be interpreted accordingly.

Measure 1

The first measure of competitiveness is similar to the one used for the NEP markets, that is, export performance of the United States relative to a given MEP country in a third MEP market. This measure was tested using the same factors that were used for the NEP markets with the addition of the openness index. These factors and their expected impact are as follows:

Factors	Expected Impact
Relative wages	Negative
Exchange rate relative to U.S. dollar	Positive
Relative number of scientists and engineers	Positive
Relative R&D expenditures	Positive
Relative gross fixed capital formation	Positive
Openness index	Positive

For the first measure, as shown in figure 6-12, the relative number of R&D scientists and engineers, annual wages per employee, capital formation, and the openness index were most often the significant factors in explaining relative export performance. R&D expenditures and exchange rates appeared least often. The lack of significance of exchange rates most likely is due to the nature of the communications equipment sold to the other MEP countries and to the procurement policies practiced in these countries. Both features make the communications equipment sold to the other MEP countries less price responsive. The range of variation explained by this estimation was between 20 and 90 percent.

The external and internal factors performed better in explaining export performance of Canada, Germany, and Japan relative to the United States (figure 6-12). France is the only competitor for which the selected external and internal factors failed to explain its export performance relative to the United States in any MEP market. The lack of significance of the R&D scientists and engineers factor for the United Kingdom was unexpected. As discussed in chapter 5, the United Kingdom is a leader in software expertise and this factor was significant in explaining the relative export performance of the United Kingdom in some of the NEP markets. With respect to competition between Sweden and United States, the significant factors were R&D scientists and engineers and exchange rates.

Measure 2

The second measure of competitiveness was used to assess head-to-head competition between U.S. equipment producers and domestic suppliers in a given MEP country. The factors and their expected impact are as follows:

Factors	Expected Impact
Relative wages	Positive
Exchange rate relative to U.S dollar	Negative
Relative number of scientists and engineers	Negative
Relative R&D expenditures	Negative
Relative gross fixed capital formation	Negative
Openness index	Positive

Except for the openness index, the direction of the expected impact for all the factors is reversed for the second measure as compared with that for the first measure. For example, U.S. exports of communications equipment to France would likely increase if annual wages in France increased relative to those in the United States. This would lead to higher costs of production in France, given that other factors do not change. Hence, a positive impact is associated with the relative wages factor. Similarly, U.S. exports to France would most likely decline as French R&D expenditures, the level of technical expertise in France (reflected by the number of French R&D scientists and engineers), and French capital formation increased relative to the United States. Hence, a negative impact is associated with these factors. Also, U.S. exports to France should decline if the franc depreciates relative to the U.S. dollar. However, the impact of the openness index remains positive, because U.S. exports to France should increase the more open the French market becomes to trade in communications equipment. The external and internal factors are similarly defined for the other MEP countries.

The impact of the external and internal factors was estimated by pooling the data for all of the other MEP markets and by running individual regressions for each MEP market. When the data for the MEP countries were pooled, the openness index, R&D expenditures, and annual wages were significant in explaining export performance of the United States relative to the other

Figure 6-12
Significant factors affecting competition between the United States and the other MEP countries in third MEP markets

MEP Competitor	MEP Market					
	Canada	France	Germany	Japan	Sweden	United Kingdom
Canada	—	R&D Expenditures		Capital formation Annual wages R&D scientists and engineers		
France		—				
Germany	Capital formation R&D Expenditures Exchange rates Openness		—		Annual wages Openness	
Japan	Capital formation R&D scientists and engineers	Openness		—		R&D scientists and engineers
Sweden		R&D scientists and engineers	Exchange rates		—	
United Kingdom	Exchange rates		Annual wages	Exchange rates	Openness	—

Source: Staff of the U.S. International Trade Commission.

MEP countries. The openness index was also estimated to be the most influential factor, matching the suggested ranking in figure 6-10. This measure explained about 75 percent of the variation in relative export performance.

In general, when the other MEP countries were considered as individual markets, the external and internal factors were not as successful in explaining head-to-head competition. However, the level of technical expertise, as measured by the number of R&D scientists and engineers, was the factor that was most often significant. It is expected that this factor would be important in determining competition between the United States and the other MEP countries because the communications equipment sold to these markets typically employs sophisticated technology or requires customization. Such technologically advanced products require greater technical expertise than that needed for the development and manufacture of terminal equipment. Further, these products are expected to be less responsive to price which may also explain the lack of significance of the exchange-rate

factor. Finally, the impact of the openness index, which was used to reflect procurement policies, was not significant. This lack of significance may indicate the limitation in quantifying procurement polices collectively when the other MEP markets are considered on an individual basis. The second measure, when tested on an individual market basis, explained between 60 to 90 percent of the variation in U.S. export performance.

The significant results obtained for the two measures of competitiveness indicate that U.S. export performance in the communications equipment markets of the other MEP countries depends on an external factor—accessibility or openness of the markets in other MEP countries, and an internal factor—the innovative potential of the U.S. industry. This is to be expected since the products sold in these markets, such as transmission and switching equipment, tend to be subjected to procurement policies and tend to be associated with sophisticated technology.

CHAPTER 7
PRINCIPAL FINDINGS

An Industry in Transition

The communications equipment industry is undergoing rapid transformation due to changes occurring throughout the world in regulation, technology, and markets. The industry, traditionally characterized by strict government regulation, slow technological change, and a limited number of purchasers, is becoming much more dynamic. The ability to adapt to a changing environment and to influence the direction of future changes will determine which firms are competitive in the industry. This section summarizes the changes that are sweeping the industry and assesses the ability of each major equipment-producing area to respond.

Technology

Technology has contributed to the restructuring of the industry in several ways. First, the scope of communication technology has broadened beyond that of the traditional telephone and telegraph. As a result, firms in many other industries now compete with the traditional communications equipment manufacturers. Second, since the cost of developing new technology has soared, companies have had to look for domestic and foreign partners to help share costs. Research and product development are key factors in the competitiveness of producers in this industry. Policies that are structured to assist firms, especially in fields where costs or risks are unusually high, can provide a competitive edge.

Striking differences have been noted between the R&D policy of the U.S. Government and those of most other countries. The principle difference is that U.S. policies emphasize defense-related and basic research whereas those of its major competitors emphasize industrial, commercial, and applications-oriented research. These distinct approaches originated during World War II and persist even now. U.S. defense expenditures, in part, enabled the United States to retain a technological and economic lead. With factories devastated by war, potential competitors in Europe and the Far East concentrated their efforts on rebuilding their manufacturing base; one of the tools they employed was government funding of industrial research.

As foreign countries rebuilt their manufacturing capabilities and strengthened their research capabilities, some developed expertise in certain basic technologies while continuing to direct more funding to applied research. The U.S. policy of supporting basic research benefitted both U.S. and foreign firms and the growth of multinational firms and international business alliances hastened the process of technology transfer. The types of industrial research done in Europe and the Far East tended to confer more immediate benefits on domestic industries.

More specifically, European and Japanese firms benefit more than North American firms from government-sponsored support of communications-related R&D. In particular, the principal foreign telecommunications authorities, generally funded by the government, perform valuable research in communications technology for their suppliers. In addition, high technology industries, including communications, are targeted by the government of some countries and benefit from policies designed to establish technological leadership. Furthermore, certain programs provided incentives to individual companies to conduct intensified research efforts. For example, Japan enacted a Key Technology Program to provide incentives for firms to conduct basic R&D in advanced technologies, such as communications, that otherwise were too risky to undertake. European countries, such as France, have incorporated research and development incentives in their industrial policy, which promotes high-technology developments.

In the U.S. communications equipment industry, AT&T traditionally maintained a tremendous competitive edge in technology through its R&D subsidiary, Bell Laboratories. The divestiture of AT&T in 1984 eliminated a major source of Bell Laboratories funding, the revenues of the RHCs. In addition, the antitrust settlement prohibitions on the RHCs remove incentives to allocate significant resources to new product development in the United States since domestic equipment sales are prohibited. Thus, divestiture may have led to a reduction in some of the resources that might otherwise be available for equipment R&D in the United States. There are indications that the RHCs are channeling R&D money overseas because of the antitrust restrictions.

Openness

Regulation, procurement, standards and testing are all changing in many countries. Liberalization of the communications service market, especially in countries such as the United States and the United Kingdom, is reportedly opening communications equipment markets to foreign suppliers.

Technological changes and changing consumer and government views toward monopoly service provision and regulation in the post-World War II period resulted in increased competition in both communications services and equipment in the U.S. market. These changes culminated in the breakup of AT&T in 1984.

Parallel developments occurred in other countries such as the United Kingdom and Japan in the 1980s. Although not as drastic as the AT&T breakup, liberalization has resulted in more competitive service and equipment supply in the United Kingdom and, to a lesser extent, Japan. More gradual changes have occurred in other countries, such as France and Germany, including the deregulation of terminal equipment and the reorganization of the government communications monopolies. However, the provision of basic communications services remains a monopoly in most countries.

In spite of increased openness in the equipment market, traditional suppliers of communications equipment continue to benefit from the embedded base of their equipment in the communications networks. Procurement policies and standards have resulted in national networks consisting of only one or two manufacturers' equipment. Operators of communications networks are reluctant to change or add new equipment suppliers because they do not want to risk problems in maintenance or systems' compatibility. Even in the liberalized U.S. market, for instance, AT&T and Northern Telecom still maintain certain advantages due to the embedded base of their equipment in the principal long distance and regional networks. In fact, the firms' entrenched position in the world's largest communications market confers a competitive advantage in other markets since large portions of marketing and development costs may be offset by sales in the domestic market alone.

Liberalization will not proceed at the same rate in all countries. In most countries, sufficient time has not passed to allow a true assessment of the effects of liberalization. However, as long as disparities exist in the openness of communications markets, producers in protected markets will enjoy a significant competitive advantage.

Export Policies

Global competitiveness is expected to be increasingly important for success in the communications equipment industry. The huge costs of developing sophisticated switching software and advanced communications technologies can no longer be supported solely by sales in the domestic market. Therefore, producers will have to penetrate foreign markets if they are to succeed in the future.

Foreign market entry will be strongly influenced by national export policies. Because global markets require rapid and efficient movement of goods between nations, export controls can place significant constraints on companies and decrease export sales. In addition, export financing is often the key to competitiveness in expanding markets with limited investment capital, such as developing countries and Eastern Europe.

A number of industry experts believe that the principal European and Japanese producers continue to hold an advantage over U.S. firms with respect to exporting. U.S. firms appear to lack marketing expertise. Early in its history, AT&T was pressured to give up its international operations and the size and rapid growth of the U.S. market provided little incentive for developing export markets. In contrast, because the individual European country markets are relatively small, European companies have traditionally had to seek out other markets to expand sales. In the process, they had to develop effective marketing skills to compete successfully in international markets. In Japan, four principal suppliers compete vigorously with one another in domestic and foreign markets. Although less developed countries in Asia, Latin America, and Africa represent large potential communications equipment markets, such countries lack resources for funding large development projects. Accordingly, they depend extensively upon long-term financing from outside sources. Industry and government officials in the United States, Europe, and Japan indicate that major European and Japanese suppliers benefit to a greater extent than U.S. producers from government financing, loan guarantees, and tied aid. With government assistance, European and Japanese communications equipment producers are able to provide both equipment and financing to countries with limited capital resources. Companies that cannot supply similar financing packages are often not invited to bid on major infrastructure projects.

Because of the importance of the embedded base, Japanese and European competitors are making costly investments in less developed communications markets with high growth potential, such as China, even though such markets currently offer little or no short-term profit or gain. It appears that these Japanese and European firms are maneuvering to become the entrenched suppliers in these markets. Other rivals, by not contributing to the embedded base, may be at a competitive disadvantage in obtaining future sales.

The United States has consistently imposed export controls on many high-technology products unilaterally in addition to COCOM member controls. In the early years, unilateral U.S. controls tended to be effective because the United States was often the sole source of certain high-technology equipment. In more recent years, sophisticated, high-technology equipment has been available from a variety of COCOM and non-COCOM sources, thus making unilateral controls less effective.

The stringency of the U.S. export-control regime has reportedly created problems for the U.S. communications equipment industry. In some cases, export sales have been lost due to the cumbersome approval process, even when the prospective sale is to a COCOM member. Other sales have been lost because an export license was not granted at all. In addition, many U.S. companies have had problems getting foreign partners to form business consortia because of the lengthy delays in getting export licenses.

Implications for Competitiveness

Technological change, liberalization, and market globalization share a common thread. Each is in a period of transition, and the pace of change in each area is increasing. Leading the way to global competition in the communications equipment industry is the growing openness in service providers' procurement policies. This trend, if it continues, will motivate equipment producers to become more competitive in order to survive. Therefore, competitiveness in the communications equipment industry ultimately depends on how firms and nations adjust to change. Those industry players that prepare

for a changing competitive environment will likely succeed; those that do not will be left behind.

The analysis in this report indicates that the industry in each major equipment-producing area, North America, Europe, and the Far East, has recognized the market's ongoing evolution. However, they vary in their ability to adjust to change due to differences in government policy. The Japanese and European governments employ policies that assist their national communications equipment producers in to developing sophisticated technological products and in selling these products in foreign markets. Nationalism and differing economic policies, however, have made coordination more difficult in the EC than in Japan.

Although the United States was the first to liberalize its communications sector, U.S. policies in general do not appear to fully reflect the globalization of the industry. In some cases, the U.S. concentration on domestic and consumer issues has prevented the domestic communications equipment industry from capitalizing on its technological and economic advantages in the international arena.

APPENDIX A
LETTERS FROM THE COMMITTEE ON FINANCE, UNITED STATES SENATE, REQUESTING THE INVESTIGATION

United States Senate

COMMITTEE ON FINANCE
WASHINGTON, DC 20510

September 27, 1990

The Honorable
Anne Brunsdale
Acting Chairman
United States International
Trade Commission
500 E Street, S.W.
Washington, D.C. 20436

Dear Madam Chairman:

The Committee on Finance has received the Commission's report identifying U.S. advanced technology manufacturing industries for monitoring and possible comprehensive study. We understand that the Commission proposes to conduct comprehensive studies of the following three industries: communications technology and equipment, pharmaceuticals, and semiconductor manufacturing and testing equipment.

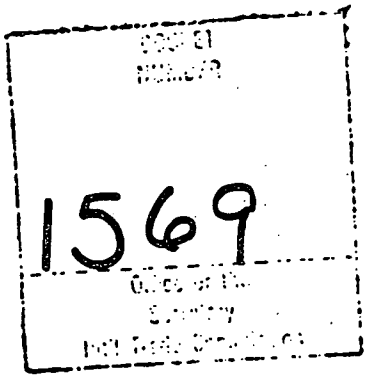
The Committee hereby approves the Commission's recommendations. As indicated in our letter of June 21, 1990, the Commission should complete the study of these three industries within 12 months.

Sincerely,

Lloyd Bentsen

United States Senate
COMMITTEE ON FINANCE
WASHINGTON, DC 20510-6200

June 21, 1990



The Honorable
Anne Brunsdale
Chairman
United States International
Trade Commission
500 "E" Street, S.W.
Washington, D.C. 20436

Dear Madam Chairman:

As part of its policymaking process, the Senate Committee on Finance anticipates a need for impartial and detailed information on the competitiveness of advanced technology manufacturing industries in the United States. As an independent Federal agency with the authority to investigate the impact of international trade upon domestic industry, it would be a logical extension of the Commission's responsibility to expand and enhance its capacity to provide information on an ongoing basis concerning the relative global competitiveness of American industry.

Accordingly, the Committee hereby requests the Commission to expand its collection of, and ability to analyze, information on the competitiveness of such industries pursuant to sections 332(b), 332(d), and 332(g) of the Tariff Act of 1930.

While the Committee wants the Commission to develop a long-term capacity on a broad range of industries, it recognizes that this expertise must evolve in stages. Thus, the Committee requests initially a two-step investigation. Within three months of the receipt of this letter, the Commission is requested to provide to the Committee a list of industries about which the Commission will develop and maintain up-to-date information. In identifying these industries, the Commission should consider the following criteria, as well as any other criteria it may choose to establish.

-- Those industries producing a product that:

(1) involves use or development of new or advanced technology, involves high value-added, involves research and development expenditures that, as a percentage of sales, are substantially above the national average, and is expected to experience above-average growth of demand in both domestic and international markets; and

(2) benefits in foreign markets from coordinated -- though not necessarily sector-specific -- policies that include, but are not limited to, protection of the home market, tax policies, export promotion policies, antitrust exemptions, regulatory policies, patent and other intellectual property policies, assistance in developing technology and bringing it to market, technical or extension services, performance requirements that mandate either certain levels of investment or exports or transfers of technology in order to gain access to that country's market, and other forms of Government assistance.

At the time the Commission provides this list of industries, the Commission is requested to recommend to the Committee three industries for comprehensive study. In selecting these industries, the Commission should consider, among any other factors it considers relevant, the importance of the industries producing these products to future U.S. global competitiveness; and the extent of foreign government benefits to industries producing competing products.

The Commission's report on these three industries should include, but is not limited to, the following information:

-- Existing or proposed foreign government policies that assist or encourage these industries to remain or to become globally competitive, existing or proposed U.S. Government policies that assist or encourage these industries to remain or become globally competitive, and impediments in the U.S. economy that inhibit increased competitiveness of these U.S. industries.

The Commission should complete the study of these three industries within 12 months of the Committee's approval of the list of recommended industries.

It would be the Committee's intention to review the report carefully in order to determine how to expand, extend, or otherwise modify this request, if necessary, to ensure that future reports continue to yield worthwhile results.

Sincerely,

Lloyd Bentsen
Chairman

APPENDIX B
THE COMMISSION'S NOTICE OF INVESTIGATION

programs for these subspecies held in captivity.

PRT-753821

Applicant: California State University, Haycoard, CA.

The applicant requests a permit to trap, mark, transport, implant with mirco telemetry transitors, and release Santa Cruz long-toed salamanders (*Ambystoma macrodactylum croceum*) in Valencia and Ellicott Ponds of Santa Cruz County, California for population censusing and monitoring of the species.

PRT-752415

Applicant: John M. Rife, Jr., Winter Park, FL.

The applicant requests a permit to import the sport-hunted trophy of one male bontebok (*Damaliscus dorcas dorcas*), culled from the captive herd maintained by M.J. D'Alton, P.O. Box 400, Bredasdorp, 7280 Republic of South Africa, for the purpose of enhancement of survival of the species.

PRT-752731

Applicant: The Planning Center, Newport Beach, CA.

The applicant requests a permit to live-trap and release Stephen's kangaroo-rats (*Dipodomys stephensi*) on the southeast quarter of section 34, T4S, R6W of Lake Mathews Quad (Riverside county), California, for preliminary biological survey purposes.

Documents and other information submitted with these applications are available to the public during normal business hours (7:45 am to 4:15 pm) room 430, 4401 N. Fairfax Dr., Arlington, VA 22203, or by writing to the Director, U.S. Office of Management Authority, 4401 N. Fairfax Drive, room 432, Arlington, VA 22203.

Interested persons may comment on any of these applications within 30 days of the date of this publication by submitting written views, arguments, or data to the Director at the above address. Please refer to the appropriate PRT number when submitting comments.

Dated: November 9, 1990.

Karen Wilson,

Acting Chief, Branch of Permits, U.S. Office of Management Authority.

[FR Doc. 90-26942 Filed 11-14-90; 8:45 am]

BILLING CODE 4310-55-M

INTERNATIONAL TRADE COMMISSION

Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries

In the matter of Investigation No. 332-301, Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Communications Technology and Equipment; Investigation No. 332-302, Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Pharmaceuticals; Investigation No. 332-303, Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Semiconductor Manufacturing and Testing Equipment.

AGENCY: United States International Trade Commission.

ACTION: Institution of investigations and scheduling of a single public hearing.

EFFECTIVE DATE: November 8, 1990.

FOR FURTHER INFORMATION CONTACT: General inquiries regarding the three names investigations may be directed to Mr. Aaron Chesser, Office of Industries (202-252-1380). Industry-specific information regarding the three investigations may be obtained from the following staff members, also located in the Office of Industries, U.S. International Trade Commission, 500 E Street SW., Washington, DC 20436:

Inv. No. 332-301 (Communications Technology and Equipment), Ms. Sylvia McDonough (202-252-1393);

Inv. No. 332-302 (Pharmaceuticals), Mr. Edmund Cappuccilli (202-252-1368); and

Inv. No. 332-303 (Semiconductor Manufacturing and Testing Equipment), Mr. Nelson Hogge (202-252-1395).

For information on legal aspects of these investigations contact Mr. William Gearhart of the Commission's Office of General Counsel (202-252-1091).

BACKGROUND: On July 20, 1990, at the request of the Senate Committee on Finance, and in accordance with section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)), the U.S. International Trade Commission instituted investigation No. 332-294, Identification of U.S. Advanced-Technology Manufacturing Industries for Monitoring and Possible Comprehensive Study. The Committee requested the Commission to expand its collection of, and ability to analyze, information on the competitiveness of advanced-technology manufacturing industries in the United States, pursuant to sections 332(b), 332(d), and 332(g) of the Tariff Act of 1930.

Specifically, the Committee requested that the Commission, under a two-stage investigation, (1) within 3 months of receipt of the letter, identify for the purpose of monitoring, using criteria provided by the Committee and any additional criteria of the Commission's choosing, U.S. advanced-technology manufacturing industries, and recommend three of those industries as subjects for comprehensive Commission studies; and (2) within 12 months of the receipt of the Committee's approval (or modification) of the Commission's recommendations, submit its report on three industries the subject of comprehensive studies.

Notice of the Commission's investigation was posted in the Office of the Secretary, U.S. International Trade Commission, Washington, DC, and published in the **Federal Register** (55 FR 30530) of July 26, 2990. All persons were afforded the opportunity to submit written views concerning the industries to be included on the list and that may be the subject of a comprehensive study.

The Commission's report on investigation No. 332-294 (USITC Publication 2319, September 1990) was transmitted to the Senate Committe on Finance on September 21, 1990. In its report, the Commission identified ten advanced-technology industries and recommended the following three for comprehensive study: communications technology and equipment; pharmaceuticals; and semiconductor manufacturing and testing equipment.

By letter of September 27, 1990, the Senate Committee on Finance acknowledged receipt of the Commission's report on investigation No. 332-294 and approved the Commission's recommendation concerning the three industries for comprehensive study; the Committee further indicated its desire that the Commission complete its study of the three industries within 12 months.

In identifying the industries to be monitored, the Committee requested that the Commission consider the following criteria as well as any other criteria it may choose—

(1) Industries producing a product that involves use or development of new or advanced technology, involves high value-added, involves research and development expenditures that, as a percentage of sales, are substantially above the national average, and is expected to experience above-average growth of demand in both domestic and international markets; and

(2) benefits in foreign markets from coordinated—though not necessarily sector specific—policies that include, but are not limited to, protection of the home market, tax policies, export promotion policies, antitrust exemptions, regulatory policies, patent and other intellectual property policies, assistance in developing technology and bringing it to market, technical or extension services, performance requirements that mandate either certain levels of investment or exports or transfers of technology in order to

gain access to that country's market, and other forms of Government assistance.

The Committee requested that the report on the three industries to be selected include at least the following information—

Existing or proposed foreign government policies that assist or encourage these industries to remain or to become globally competitive, existing or proposed U.S. Government policies that assist or encourage these industries to remain or become globally competitive, and impediments in the U.S. economy that inhibit increased competitiveness of these U.S. industries.

As requested by the Committee, the Commission will attempt to include the aforementioned information in its reports.

PUBLIC HEARING: A consolidated public hearing in connection with the three investigations will be held in the Commission Hearing Room, 500 E Street SW., Washington, DC 20436, beginning at 9:30 a.m. on January 17, 1991, and continuing as required on January 18, 1991. All persons shall have the right to appear by counsel or in person, to present information, and to be heard. Persons wishing to appear at the public hearing should file requests to appear and should file prehearing briefs (original and 14 copies) with the Secretary, United States International Trade Commission, 500 E St., SW., Washington, DC 20436, not later than the close of business on January 3, 1991. Posthearing briefs must be filed by January 31, 1991.

WRITTEN SUBMISSIONS: In lieu of or in addition to appearances at the public hearing, interested persons are invited to submit written statements concerning the investigations. Written statements are encourage early in the investigative process, but should be received no later than the close of business on June 7, 1991. Commercial or financial information which a submitter desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly market "Confidential Business Infromation" at the top. All submissions requesting confidential treatment must conform with the requirements of § 201.6 of the Commission's *Rules of Practice and Procedure* (19 CFR 201.6). ALl written submissions, except for confidential business information, will be made available for inspection by interested persons. All submissions should be addressed to the Office of the Secretary of the Commission in Washington, DC.

Hearing-impaired individuals are advised that information on this matter can be obtained by contacting the Commisison's TDD terminal on (202) 252-1810.

By order of the Commission.

Issued: November 8, 1990.

Kenneth R. Mason,

Secretary.

[FR Doc. 90-26928 Filed 11-14-90; 8:45 am]

BILLING CODE 7020-02-M

[Inv. No. 337-TA-311]

Certain Air Impact Wrenches; Commission Decision Not to Review an Initial Determination Designating the Investigation More Complicated

AGENCY: U.S. International Trade Commission.

ACTION: Notice.

SUMMARY: Notice is hereby given that the U.S. International Trade Commission has determined not to review an initial determination (ID) issued by the presiding administrative law judge (ALJ) designating the above-captioned investigation more complicated and extending the administrative deadline for filing the final ID by three months. The Commission has also extended the deadline for completion of the investigation by three months, *i.e.*, until August 5, 1991.

ADDRESSES: Copies of the ID and all other nonconfidential documents filed in connection with this investigation are available for inspection during official business hours (8:45 a.m. to 5:15 p.m.) in the Office of the Secretary, U.S. International Trade Commission, 500 E Street, SW., Washington, DC 20436, telephone 202-252-1092.

Hearing-impaired individuals are advised that information on this matter can be obtained by contacting the Commission's TDD terminal on 202-252-1810.

SUPPLEMENTARY INFORMATION: On October 3, 1990, the presiding ALJ issued an ID designating the investigation more complicated and extending the administrative deadline for filing the ALJ's final ID by three months. No petitions for review or agency comments were received. The investigation was designated more complicated because of the serious illness of the president of respondent Astro Pnenmatic Tool Co. (Astro) that temporarily jeopardizes the ability of Astro and respondent Kuan-I Gear Co. to defend themselves in the investigation.

Authority for the Commission action is found in section 337(b)(1) of the Tariff Act of 1930 (19 U.S.C. 1337(b)(1)) and in Commission interim rule 210.59 (19 CFR 210.59).

By order of the Commission.

Issued: November 7, 1990.

Kenneth R. Mason,

Secretary.

[FR Doc. 90-26926 Filed 11-14-90; 8:45 am]

BILLING CODE 7020-02-M

[Investigation No. 731-TA-455 (Final)]

Certain Laser Light-Scattering Instruments and Parts Thereof From Japan

Determination

On the basis of the record [1] developed in the subject investigation, the Commission determines,[2] pursuant to section 735(b) of the Tariff Act of 1930 (19 U.S.C. 1673d(b)) (the act), that an industry in the United States is threatened with material injury [3] by reason of imports from Japan of certain laser light-scattering instruments (LLSIs) and parts thereof,[4] provided for in subheadings 9027.30.40 and 9027.90.40 of the Harmonized Tariff Schedule of the United States, that have been found by the Department of Commerce to be sold in the United States at less than their fair value (LTFV).

Background

The Commission instituted this investigation effective July 6, 1990, following a preliminary determination by the Department of Commerce that imports of LLSIs and parts thereof from Japan were being sold at LTFV within the meaning of section 733(a) of the act (19 U.S.C. 1673b(a)). Notice of the institution of the Commission's investigation and of a public hearing to be held in connection therewith was

[1] The record is defined in sec. 207.2(h) of the Commission's Rules of Practice and Procedure (19 CFR 207.2(h)).

[2] Acting Chairman Brunsdale and Commissioner Lodwick dissenting.

[3] Commissioners Rohr and Newquist further determine that, pursuant to section 735(b)(4)(B), they would not have found material injury by reason of the imports subject to the investigation but for the suspensions of liquidation of the entries of the subject merchandise.

[4] The products covered by this investigation are laser light-scattering instruments and parts thereof from Japan that have classical measurement capabilities, whether or not also capable of dynamic measurements. The following parts are included in the scope of the investigation when they are manufactured according to specifications and operational requirements for use only in such an LLSI: Scanning photomultiplier assemblies, immersion baths, sample-containing structures, electronic signal-processing boards, molecular characterization software, preamplifier/discriminator circuitry, and optical benches.

APPENDIX C
CALENDAR OF WITNESSES APPEARING AT THE PUBLIC HEARING

As of 1/11/91

TENTATIVE CALENDAR OF PUBLIC HEARING

Those listed below are scheduled to appear as witnesses at the United States International Trade Commission's hearing:

Subject	:	GLOBAL COMPETITIVENESS OF U.S. ADVANCED TECHNOLOGY MANUFACTURING INDUSTRIES: COMMUNICATIONS TECHNOLOGY AND EQUIPMENT; PHARMACEUTICALS; AND SEMICONDUCTOR MANUFACTURING AND TESTING EQUIPMENT
Inv. Nos.	:	332-301 through 303
Date and Time:	:	January 17 (& 18), 1991

Sessions will be held in connection with the investigation in the Main Hearing Room 101, United States International Trade Commission, 500 E Street, S.W., in Washington, D.C.

Government Witnesses:

Robert Scace, National Institute of Standards and Technology, U.S. Department of Commerce (332-303)

WITNESS AND ORGANIZATION:	INV. NO.	TIME CONSTRAINTS
Pharmaceutical Manufacturers Association Washington, D.C. Gerald J. Mossinghoff, President	332-302	10 Minutes
Industrial Biotechnology Association Washington, D.C. Lisa Raines, Director of Government Relations	332-302	10 Minutes
North American Telecommunications Association, Washington, D.C. Edwin B. Spievack, President	332-301	10 Minutes

- more -

WITNESS AND ORGANIZATION:	INV. NO.	TIME CONSTRAINTS
United States Advanced Ceramics Association Washington, D.C. Steven B. Hellem, Executive Director	332-303	10 Minutes
Semi/Sematech Austin, Texas Peggy Haggerty, Vice Presdient of Public Policy (representing over 130 U.S. Semiconductor Equipment and Materials Suppliers)	332-303	10 Minutes
Lithography Systems, Inc. Wilton, Connecticut Vahe Sarkissian, President	332-303	10 Minutes
Semiconductor Equipment and Materials International (SEMI) Washington, D.C. Joel Elftmann, Chairman, SEMI Board of Directors and Chairman, FSI International, Inc. Michael Ciesinski, Director, North American Operations Victoria Hadfield, Manager, Government Relations	332-303	10 Minutes

APPENDIX D
BIBLIOGRAPHY OF SOURCES

Selected Bibliography

Douglas D. Anderson, "State Regulation of Electric Utilities," *The Politics of Regulation*, edited by James Q. Wilson, (New York: Basic Books, 1980).

AT&T, *Annual Report for 1989*.

The Atlantic Council of the United States, *The U.S. Telecommunications Services and Equipment Sector and the European Community Unified Market - 1992*, Washington, DC, 1990.

Barbara N. Berkman, "Ericsson is Restructuring to Adapt to a Deregulated Global Market," *Electronic Business*, Jan. 21, 1991.

Harvey Blustain, Richard Guenther, John Lawlor, and Paul Polishuk, *U.S. Long Distance Fiber Optic Networks: Technology, Evolution, and Advanced Concepts*, Boston, MA: IGI Consulting, Inc., 1986.

Roger Alan Boner and Reinald Krueger *The Basics of Antitrust Policy: A Review of Ten Nations and the EEC*, October 1990.

British Telecom, *Annual Report on Form 20-F 1990*, Filed with the U.S. Securities and Exchange Commission on September 17, 1990.

John Brooks, *Telephone: The First Hundred Years*, New York: Harper and Row, 1975.

Robert R. Bruce, Jeffrey P. Cunard, and Mark D. Director, "Telecommunications Structures in the Developing World: An Essay on Telecommunications and Development," ch. in *The Telecom Mosaic: Assembling the New International Structure*, United Kingdom Butterworth, 1988.

Michael Calingaert, *The 1992 Challenge from Europe*, Washington, DC: The National Planning Association, 1988.

Cap Gemini Sogeti, *Annual Report, 1989*.

Carl F. Cargill, *Information Technology Standardization, Theory, Process, and Organizations*, Digital Equipment Press, 1989.

David Charles, Peter Monk, and Ed Sciberras, *Technology and Competition in the International Telecommunications Industry*. London: Pinter Publishers Limited, 1989.

R.B. Cohen, R.W. Ferguson, and M.F. Oppenheimer, *Nontariff Barriers to High-Technology Trade*, Boulder, CO: Westwood Press, 1985.

Andrew Collier, "Siemens Seeks Switch Scheme Tie," *Electronic News*, Mar. 18, 1991.

EC Commission, *Research and Development in Advanced Communication Technologies in Europe*, 1990.

Peter Cowhey, "Telecommunications," ch. in *Europe 1992: An American Perspective*, Washington, DC: The Brookings Institution, 1990.

Robert W. Crandall, *After the Breakup: U.S. Telecommunications in a More Competitive Era*, Washington, DC: The Brookings Institution, 1991.

Robert W. Crandall and Kenneth Flamm, *Changing the Rules: Technological Change, International Competition, and Regulation in Telecommunications*, Washington, DC: The Brookings Institution, 1989.

Dwight B. Davis, "The Missing Links in the Fiber-Optics Market," *Electronic Business*, Jan. 22, 1990.

EC Commission, "Telecommunications Equipment," *Panorama of EC Industry*, Paris and Luxembourg, 1989.

EC Council, Directive 90/287, *Official Journal of the European Communities (OJ)*, No. L 192, June 28, 1990.

EC Council, Directive 90/531, *OJ*, No. L 297, Sept. 17, 1990.

Elsevier Advanced Technology, *Profile of the Worldwide Telecommunications Industry*, London, 1991.

L.M. Ericsson, *Annual Report to Section 13 or 15(d) of the Securities Exchange Act of 1934*, Dec. 31, 1989.

Ernst & Young, *American Competitiveness Study: Characteristics of Success*, E&Y No. 58059, 1990.

EC Commission, EUREKA Secretariat, *Together for the Future*, Luxembourg.

EC Commission, EUREKA, *Annual Project Report*, Luxembourg 1989.

Export-Import Bank of the United States, *Report to the U.S. Congress on Tied Aid Credit Practices*, 1989.

M.D. Fagen, *History of Engineering and Science in the Bell System: The Early Years*, Cambridge, MA: Ballinger Publishing Co., 1987.

Gerald R. Faulhaber, *Telecommunications in Turmoil: Technology and Public Policy*, Cambridge, MA: Ballinger Publishing Co., 1987.

Federal Communications Commission, "Brief History of Part 68," ch. in *Instruction for Form 730: Registration of Telephone and Data Equipment*, Washington, DC, April 1991.

Federal Ministry of Posts and Telecommunications (Germany), *Development of the Telecommunications Policy in Germany: A Status Report*, 1991.

James Foreman-Peck and Jurgen Muller, "The Changing European Telecommunications Systems," ch. in *European Telecommunication Organisations*, Baden-Baden, Germany: Nomos Verlagsgesellschaft, 1988.

Hans Peter Gassman "Telecommunications Services in a Global Marketplace," presented to the conference on UK Telecommunications Policy, London, UK, April 9-10, 1991

George Gilder, "Into the Telecosm," *Harvard Business Review*, March-April 1991.

Jane G. Gravelle, *The Tax Credit for Research and Development: An Analysis*, Report No. 85-6 E Congressional Research Service, The Library of Congress, (Washington, DC: Jan. 25, 1985).

Fred Guteri, "Ericsson Bets on a Cellular World," *IEEE Spectrum*, 1991.

Robert G. Harris, "Divestiture and Regulatory Policies," *Telecommunications Policy* April 1990.

Jerry A. Hausman, *An Economic and Regulatory Assessment of Joint Ventures, Strategic Alliances and Collaboration in Telecommunications*, Presented at the Telecommunications Business and Economics Symposium, Massachusetts Institute of Technology, Cambridge, MA, Nov. 30, 1989.

Selected Bibliography—*Continued*

Jerry A. Hausman and Elon Kohlberg, "The Future Evolution of the Central Office Switch Industry," ch. in *Future Competition in Telecommunications*, Cambridge, MA: Harvard University, 1989.

R.H. Hayes and W.J. Abernathy, "Managing Our Way to Economic Decline," *Harvard Business Review*, July-August 1980.

Kawamoto Hirotaka, *Key Technology Center: Status and Future Perspectives*, Tokyo: Japan Technology Program, 1990.

Michael Hobday, *Telecommunications in Developing Countries: The Challenge from Brazil*, London and New York: Routledge, Chapman and Hall, Inc., 1990.

Thomas R. Howell et al, *The Microelectronics Race: The Impact of Government Policy on International Competition*, Westview Press, 1988.

Kenneth S. Hoyt and Edgar Grabhorn, "Where is the Money Going," *Telephone Engineer & Management*, January 15, 1990.

Manley R. Irwin, "The Telecommunications Industry," ch. in *The Structure of American Industry*, edited by Walter Adams, New York: Macmillan, 1990.

Y. Ito, "Telecommunications and Industrial Policies in Japan: Recent Developments," ch. in *Telecommunications Regulation and Deregulation in Industrial Democracies*, Amsterdam: North-Holland, 1986.

Japan External Trade Organization, *Your Market in Japan: Telecommunications Equipment*, Tokyo, March 1990.

The Japan Key Technology Center, *Japan Key Technology Center: Guide Book for Capital Subscription and Financing Systems*, Tokyo, 1991.

"Japan's MPT Targets 2015 for Optical Conversion," *Lightwave*, January 1991.

Jie-Ae, "Decentralization Lightens the Load at the Top," *Business Korea*, April 1991.

Christopher Johnson and Joseph E. Flynn, "The Race for Photonic Leadership," *Photonic Spectra*, February 1991.

Chalmers Johnson, *MITI, MPT, and the Telecom Wars: How Japan Makes Policy for High Technology*, Berkeley Roundtable on the International Economy, Berkeley, CA: University of California, September 1986.

Heung-Sup Kim, "New Procurement Procedures of Korea Telecom," *The Third Korea-U.S. Telecommunications Private Sector Consultation*, Sponsored by Telecommunications Industry Association and Korea Telecom, Washington, DC: January 31, 1991.

Fumio Kodama, *Analyzing Japanese High Technologies: The Techno-Paradigm Shift*, London: Pinter Publishers, 1991.

Robert Kutner, "Export Controls: Industrial Policy in Reverse," Washington, DC: Economic Policy Institute, September 1990.

Ralph Landau and Dale W. Jorgenson, *Technology and Economic Policy*, Cambridge: Ballinger Publishing Company.

Teddi C. Laurin, "Straightening Out Export Controls," *Photonics Spectra*, October 1990.

David J. Markey and Robert T. Blau, "Is the AT&T Consent Decree Strangling American R&D?" *Telematics*, August 1986.

James Martin, *Telecommunications and the Computer*, Englewood Cliffs, NJ: Prentice Hall, 1990.

Roy Merrils, "How Northern Telecom Competes on Time," *Harvard Business Review*, July-August 1989.

Ministry for Posts, Telecommunications and Space (France), *A New Era in French Telecommunications, Advanced Technologies and Business Opportunities*, April 1991.

David C. Mowery and Nathan Rosenberg, *Technology and the Pursuit of Economic Growth*, Cambridge University Press, 1989.

Tsuruhiko Nambu, Kazuyuki Suzuki, and Tetsushi Honda, "Deregulation in Japan," ch. in *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, Washington, DC: The Brookings Institution, 1989.

National Academy of Sciences, *Balancing the National Interest: U.S. National Security Export Controls and Global Economic Competition*, Washington, DC: National Academy Press, 1987.

National Academy of Sciences, *Finding Common Ground: U.S. Export Controls in a Changed Global Environment*, Washington, DC: National Academy Press, 1991.

Eli M. Noam, "International Telecommunications in Transition," ch. in *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, Washington, DC: The Brookings Institution, 1989.

North American Telecommunications Association, *Telecommunications Market Review and Forecast*, Washington, DC, 1991.

North American Telecommunications Association, *Industry Basics: Introduction to the History, Structure and Technology of the Telecommunications Industry*, Washington, DC, 1989.

North American Telecommunications Association, *EuroTelecom*, Washington, DC, 1990.

National Science Foundation, "International Science and Technology Data Update," Washington, DC, 1988.

Organization for Economic Cooperation and Development (OECD), *Industrial Policy in OECD Countries: Annual Review*, Paris, 1990.

OECD, Information Computer Communications Policy, "The Telecommunications Industry: the Challenges of Structural Change," draft report, Paris, 1991.

OECD, *Science and Technology Indicators Report #3*, Paris, 1989.

OECD, *Satellites and Fibre Optics: Competition and Complementarity*, Paris, 1988.

OECD, *Telecommunications Equipment: Changing Markets and Trade Structures*, Paris: ICCP Report number 24.

Office for Official Publications of the European Community, *Research and Technological Development Policy*, Periodical 2/1988, 1988.

Robert M. Orr, Jr., *The Emergence of Japan's Foreign Aid Power*, New York: Columbia University Press, 1990.

J.C. Panzer and R.D. Willig, "Economics of Scope," *American Economic Review*, Vol. 71, No. 2, May 1981.

Michael E. Porter, *The Competitive Advantage of Nations*, New York: The Free Press, 1990.

Ernest H. Preeg, *The Tied Aid Issue: U.S. Export Competitiveness in Developing Countries*, Washington, DC: The Center for Strategic and International Studies, 1989.

President's Commission on Industrial Competitiveness, *Global Competition: The New Reality*, Washington, DC: Vol. 1, 1985.

Quick, Finan and Associates, *The U.S. Trade Position in High Technology: 1980-1986*, Washington, DC: Quick, Finan and Associates, October 1986.

Leonard Reich, "Research, Patents, and the Struggle to Control Radio: A Study of Big Business and the Uses of Industrial Research," *Business History Review*, 1977.

"Research: Common Position on Communication Technologies Programme, "*European Report*, Mar. 6, 1991, Section IV.

R.F. Rey, *Engineering and Operations in the Bell System*, Murray Hill, NJ: AT&T Bell Laboratories, 1983.

Walter Sapronov, "A Primer on Telecommunications Law and Regulation," ch. in *Telecommunications and the Law: An Anthology*, Computer Science Press.

F.M. Scherer and David Ross, *Industrial Market Structure and Economic Performance*, Boston: Houghton Mifflin Company, 1990.

Joseph Schumpeter and Nikolai Kondratieff, *High Technology Policies: A Five Nation Comparison*, Washington, DC: American Enterprise Institute for Public Policy Research, 1984.

E. Sciberras and B.D. Payne, *Telecommunications Industry*, London: St James Press, 1986.

Robert Sobel, *ITT: The Management of Opportunity*, New York: The New York Times Book Co., 1982.

"Sweden Gets First Telecom Competitor," *FCC Week*, Apr. 22, 1991.

Tax Reform Act of 1986: Report of the Committee on Finance... [on] H.R. 3838..., Rept. 99-313, 99th Con., 2d session.

Testimony of the Swedish Telecom Group before the National Telecommunications and Information Administration, Apr. 9, 1990, Docket No. 91296-9296.

U.S. Congress, Office of Technology Assessment, *Critical Connections: Communications for the Future*, (OTA-CIT-407), 1990.

U.S. Department of Commerce, Bureau of Export Administration, *1991 Annual Foreign Policy Report to the Congress.*

U.S. Department of Commerce, *A Competitive Assessment of the U.S. Digital Central Office Switch Industry*, Washington, DC: International Trade Administration, 1986.

U.S. Department of Commerce, *The Competitive Status of the U.S. Electronics Sector, From Materials to Systems*, Washington, DC: International Trade Administration, 1990.

U.S. Department of Commerce, *Factory Automation in Japan: Key Trends and Innovations*, Washington, DC: National Technical Information Service, 1988.

U.S. Department of Commerce, *NTIA Telecom 2000: Charting the Course for a New Century*, Washington, DC, October 1988.

U.S. Department of Commerce, *NTIA Trade Report: Assessing the Effects of Changing the AT&T Antitrust Consent Decree*, Washington, DC, 1987.

U.S. Department of Commerce, "Telephone and Telegraph Equipment," *U.S. Industrial Outlook 1991*, Washington, DC, GPO, January 1991.

U.S. Department of Commerce, *U.S. Telecommunications in a Global Economy: Competitiveness at a Crossroads*, August 1990.

U.S. Department of State, "Report on Japanese Technology Policy: The Mechatronic Revolution 1975-85 and Techno-Paradigm Shift: 1985-Present," unclassifed telegram, Tokyo, January 1991.

U.S. General Accounting Office, *Electronic Funds Transfer, Information on Three Critical Banking Systems*, Feb. 1, 1988.

U.S. International Trade Commission (USITC), *Changes in the U.S. Telecommunications Industry and the Impact of U.S. Telecommunications Trade*, USITC publication 946, June 1984.

USITC *The Effect of Greater Integration Within the European Community on the United States*, USITC Publication 2204, July 1989.

USITC *The Effect of Greater Economic Integration Within the European Community on the United States: Second Followup Report*, publication 2318, September 1990.

USITC *Foreign Industrial Targeting and Its Effects on U.S. Industries, Phase II, The EC and Member States*, USITC publication 1517, April 1984.

USITC *Identification of U.S. Advanced-Technology Manufacturing Industries for Monitoring and Possible Comprehensive Study*, USITC publication 2319, September 1990.

USITC *U.S. Global Competitiveness: Optical Fibers Technology and Equipment*, USITC publication 2054, 1988.

Herbert Ungerer, *Telecommunications in Europe: Free Choice for the User in Europe's 1992 Market*, Luxembourg: Office for Official Publications of the European Communities, 1988.

Bob Whitehouse, "The Swedes Try Out Liberalization," *Communications International*, November 1989.

Caneee Wilde, "Philips To Sell AT&T Stake," *Communications Week*, Sept. 24, 1990.

Lamont Wood, "Ringing up new business with PBXs," *Datamation*, Aug. 15, 1990.

APPENDIX E
LIST OF CONTRIBUTING COMPANIES, ASSOCIATIONS, AND RESEARCHERS

LIST OF CONTRIBUTING COMPANIES, ASSOCIATIONS, AND RESEARCHERS

Alcatel
American Electronics Association
American Express
American Chamber of Commerce, Korea
AT&T
Bell Northern Research
Bell Atlantic
British Telecom
Citibank
COMDIAL
Communications Industry Association of Japan
Corning Glassworks
Daewoo Telecom Corporation
Deutsche Bundespost Telekom
Directorate for General Regulation (France)
Embassy of Japan
Ericsson
European Commission
France Telecom
French Telecommunication Equipment Manufacturers Association
Fujitsu
Fujitsu Limited
GE
GEC Plessy Telecommunication (GPT)
German Machine Tool Builders' Association (VDW)
Goldstar Fiber Optics Company, Ltd.
Hitachi Cable Ltd.
IBM
IGI Consulting
International Telecommunications Users Group (INTUG)
Japan Telecom
Jardine Fleming Securities, Ltd.
Kokusai Denshin Denwa Company, Ltd. (KDD)
Korea Telecom
Korea Mobile Telecommunications Corporation
Korea Industrial Property Office
Lasertron, Incorporated
Massachusetts Institute of Technology
Ministry of International Trade and Industry (Japan)
Ministry of Posts and Telecommunications (Germany)
Ministry of Trade and Industry (Korea)
Ministry of Communications (Korea)
Ministry of Posts and Telecommunications (Japan)
Motorola Incorporated
NEC Corporation
Nippon Telegraph and Telephone Corporation
Nippon Motorola Corporation
North Carolina Japan Center
North American Telecommunications Association
Northern Telecom
NTIA
OECD
Office of Telecommunications (UK)

LIST OF CONTRIBUTING COMPANIES, ASSOCIATIONS, AND RESEARCHERS—*Continued*

Salomon Brothers
Samsung Electronics Company, Ltd.
Science Policy Research Unit — University of Sussex
Security Pacific National Bank
Siemens
Society for Worldwide Interbank Financial Telecommunication (SWIFT)
Sophia University
Standard Electrik Lorenz (SEL)
STM Corporation
Sumitomo Electric Corporation
Telecommunications Industry Association
Telecommunications Research Center (UK)
Teleway Japan
The Association of the Electronics, Telecom. and Business Equipment Industries
The Association for Manufacturing Technology
U.S. Department of Commerce
U.S. Embassy, Seoul
U.S. Embassy, Tokyo

APPENDIX F
REVIEW OF LITERATURE ON INTERNATIONAL COMPETITIVENESS

This appendix reviews the literature on international competitiveness in general as well as two attempts that have been made to measure this economic concept. The studies reviewed focus primarily on competitiveness at the national level and not at the industry or firm level.

Review of Literature

There is a general consensus in the literature that national competitiveness represents a dynamic concept that goes beyond examining a country's trade performance in terms of price and cost factors. These factors are partial determinants of output levels as well as an industry's ability to sell in the domestic and international markets. Increasingly, other factors, such as product quality, serviceability and product innovations, are seen as instrumental for an industry's competitive success in home and global markets. Due to the rapid pace of technical change, particularly in the high-technology industries, research and development and innovation efforts are critical to improving process and product design on a continuous basis. Consequently, industry must make efforts to upgrade worker and managerial skills as well as to improve the manufacturing process. The resulting higher productivity implies higher incomes which in turn contribute to higher standards of living.

There is agreement in the literature that in order to enhance its international competitiveness, the United States needs to: (a) improve the ability of its firms to develop and use technology; (b) improve the ability of its firms to mobilize capital resources; and (c) improve all aspects of human resource use throughout the economy. However, there is disagreement in the literature as to how the United States can achieve these goals so that it can be competitive in the global market. There are three different policy perspectives offered in the literature as a whole: the activist industry policies perspective; the neomercantilist or the managed trade perspective; and the neoclassical and/or liberal economics perspective. Each of these views will be described briefly below. This presentation will then be followed by a brief description of the two attempts that have been made to measure competitiveness at the national level. Finally, this section presents a brief summary of the literature survey.

The first two perspectives essentially belong to the school of thought that recommends a very active government role in shaping a nation's trade policy. They use the performance of the Japanese economy as a basis for their recommendations in formulating a strategic U.S. trade policy. The difference between the proponents of the activist industrial policies and the proponents of managed trade lies in the selection of industries targeted for government assistance.

Activist Industry Policies Perspective

The advocates of industry-specific policies in the early 1980s recommended a very active government role in enabling all industries within an advanced economy to shift their production towards higher value-added and more competitive outputs.[1] Industries are categorized into three types of businesses: low-skilled, standardized businesses declining in the face of strong competition from newly industrialized countries; cyclical businesses which typically entail high fixed costs in plant, equipment and labor; and high-skilled emerging businesses which are characterized by rapid technological change.

In the case of declining industries, the proponents of activist industry policies recommend that agreements between the United States and governments of other advanced nations should be worked out to ease the adjustment of the less competitive firms by granting them subsidies as well as protecting them from imports, as needed for a limited period. In addition, government funds should be provided for worker retraining. In the case of cyclical businesses, the United States should discourage foreign export subsidies and below-cost pricing; provide long-term financing to prevent unemployment and postponement of investment in new equipment; and subsidize the upgrading of worker skills. Finally, in the case of high value-added emerging businesses, the U.S. Government should provide subsidies, loan guarantees, and tax benefits to encourage the industries to locate at home rather than abroad. Such an incentive

[1] M. Wachter and S. Wachter, eds., *Toward a new U.S. Industrial Policy*, University of Pennsylvania, 1982; I. Magaziner and R. Reich, *Minding America's Business*, HBJ, 1982; F. Adams and L. Klein eds., *Industrial Policies for Growth and Competitiveness: An Economic Perspective*, D.C. Heath, 1982; R. Reich, "Beyond Free Trade", *Foreign Affairs* 61:4, 1983; C. Shultze, "Industrial Policy: A dissent," *The Brookings Review*, Fall 1983; and C. Johnson, ed., *The Industrial Policy Debate*, Institute for Contemporary Studies, 1984.

package is recommended for these emerging businesses since they are expected to lead to future advances which would translate into improved national welfare. A more recent study advocated an activist set of employment and technology policies involving large federal and state labor force training and technological extension services for small businesses.[2] The study also suggested providing extensive federal research support for selective industries ("winners").

Neomercantilist Or Managed Trade Perspective

The neomercantilists, or proponents of managed trade consider international trade to be managed rather than free because most governments, including the U.S. Government, are actively intervening in trade.[3] These interventions include export subsidies and import restrictions as well as agreements covering voluntary export restraints (VERs) and voluntary import expansion (VIEs). Managed trade can be broadly defined as trade that is controlled, directed, or administered by government policies and conducted by either bilateral or multilateral agreements. Multilateral agreements are recommended over bilateral as the latter discriminate against excluded parties and typically result in increased trade friction. Multilateral agreements having a larger number of participants usually result in less discriminatory outcomes.

The neomercantilists recommend some form of managed trade in high-technology industries since these industries are important for the economy as a whole. The strategic nature of these industries emanates from their potential to generate important externalities which imply economic benefits for the economy. Hence, the neomercantilists suggest that the fate of these industries cannot be left solely to market forces, particularly in the presence of activist government intervention abroad. Also, high-technology products account for a significant and growing share of U.S. trade--approximately 38 percent of nonagricultural merchandise exports and 25 percent of nonpetroleum merchandise imports in 1988.[4] Further, according to managed trade proponents, trade arrangements that would result in increased exports and reduced imports of such products would require a smaller decline in the dollar's value to help adjust the U.S. trade imbalance, resulting in a lower loss in real income.

Managed trade could be "result-oriented" where quantitative trade targets could be negotiated with appropriate trading partners by utilizing VERs and/or VIEs. Managed trade proponents consider the use of VERs and VIEs as increasing both competition and trade flows, unlike the free trade advocates who consider their use to be restrictive in nature. Managed trade proponents use Japanese trade performance to support their views since they consider Japan's success as a case study of how a country can realize its trade-related goals through extensive, but carefully planned, protectionism.

Neoclassical/Liberal Economics Perspective

The proponents of the neoclassical/liberal economics perspective reject activist and managed trade policy recommendations for enhancing the U.S. economy's international competitiveness because to pursue such a strategic trade policy would require vast amounts of information about the economy and the suggested externalities associated with targeted industries.[5] Also, in this literature in general, most economists believe that such policies would likely reduce competition, raise costs for other sectors within the economy, and result in trade wars. According to the neoclassical/liberal economic perspective, the way to promote the U.S. economy's international competitiveness and hence

---

[2] U.S. Congress, Office of Technology Assessment, *Making Things Better: Competing in Manufacturing*, OTA-ITE-443, U.S. Government Printing Office, February 1990.

[3] R. Reich, "Beyond Free Trade," *Foreign Affairs* 61:4, 1983; J. Goldstein and S. Krasner, "Unfair Trade Practices: The Case for a Differential Response," *American Economic Review* 74:2, May 1984; L. Tyson, "Managed Trade: Making the Best of Second Best," in Lawrence, R. and C. Shultze, eds., *An American Trade Strategy: Options for the 1990's*, Brookings, 1990; R. Dornbusch, "Policy Options for Freer Trade: the Case for Bilaterlism," in R. Lawrence and C. Shultze, eds., *The American Trade Strategy: Options for the 1990's*, Brookings, 1990.

[4] L. Tyson, "Managed Trade: Making the Best of Second Best," in Lawrence, R. and C. Shultze, eds., *An American Trade Strategy: Options for the 1990's*, Brookings, 1990.

[5] U.S. President's Commission on Industrial Competitiveness, *Global Competition: The New Reality*, 1985; A. Dixit, "Trade Policy: An Agenda for Research," in P. Krugman, ed., *Strategic Trade Policy and the New International Economics*, MIT 1986; G. Hatsopoulos, P. Krugman and L. Summers, "U.S. Competitiveness; Beyond the Trade Deficit," *Science*, July 15, 1988; M. Dertouzos, K. Lester, and R. Solow, *Made in America: Regaining the Competitive Edge*, MIT, 1989; M. Porter, *The Competitive Advantage of Nations*, Free Press 1990; R. Landau, "Capital Investment: Key to Competitiveness and Growth," *The Brookings Review*, Summer 1990.

raise its standard of living is to let private markets function and have the U.S. Government pursue policies that create a stable economic environment. The U.S. Government can promote such an economic environment by maintaining an advanced economic infrastructure, correcting market failures in technology, encouraging research and development, promoting human resource development, and striving continuously for liberal trade policies worldwide. The U.S. Government's role is emphasized in pursuing those macroeconomic policies that would stimulate savings and reduce the federal budget deficit, which in turn would stimulate investment and productivity growth. There is, however, a divergence of opinion among the proponents of liberal economic policies as to the role firms play in enhancing the nation's international competitiveness. This divergence of opinion is presented in three major studies whose recommendations are summarized below.

A report by the President's Commission on Industrial Competitiveness in 1985[6] focused primarily on government's initiatives in four areas: (a) provide incentives towards technological advances, for example, by enhancing tax credits for private sector R&D; (b) enhance the availability of capital at lower cost by reducing the federal budget deficit and by restructuring the tax system to encourage higher savings and investment; (c) enhance human resources by improving the educational system at all levels; and (d) give high priority to trade matters. The commission had few recommendations as to how firms could improve their competitiveness. The report did recommend that firms should improve their manufacturing capabilities, de-emphasis simple short-term financial measures, and establish a cooperative relationship between labor and management. No recommendations were provided on how firms might achieve these goals.

In contrast, a MIT study on industrial productivity[7] focusses on what firms should do to improve their competitiveness in the international market. The role of the U.S. Government is recognized to the extent it could reduce the federal budget deficit and restructure the tax system to provide incentives for achieving a higher savings rate. The study highlights the weaknesses associated with industrial production in the U.S economy. Some of these limitations stated in this study include a reliance on outdated marketing strategies, technological weakness in development and production, neglect of human resources due to limited formal and extensive on-the-job training, managing production in a short-sighted manner, and failures in labor-management cooperation. The study reported that successful firms were characterized by simultaneous improvement in quality, cost, and delivery; close relationships with consumers and suppliers; technology that was integrated with planning, manufacturing, marketing and human resources; and innovative human resource policies.

The Porter study recommends a role for both firms and the U.S Government. Porter states that the nation's standard of living depends on the productivity of its capital and labor resources, and that productivity is the root of competitiveness and prosperity. Porter argues that the nation's competitive advantage depends on four key, interrelated features of an economy: factor conditions, demand conditions, related and supporting industries, and firm strategy and rivalry. If these four features of the economy are strong, a nation will be better off in the long term. Porter's recommendations for U.S. Government initiatives are: maintain a strong antitrust policy in order to foster domestic competition; maintain an open trade policy and avoid devaluation to boost exports; create incentives for higher savings and allow interest rates to fall so as to encourage investment and longer time horizons on R&D projects; and fund university research centers in order to rejuvenate national R&D.

Porter's recommendations for firms involve dedication to relentless upgrading, improvement, and innovation at all levels of the value chain from R&D to after-sales service. Porter suggests that firms should sell to more sophisticated and demanding customers in order to feel the pressure to innovate; treat employees as permanent in order to enhance their skill level; and be willing to help upgrade local suppliers in order to reap the rewards of informal collaboration with them. Porter's study is one of the few studies in the literature that emphasizes the service sector as well as the manufacturing sector.

Measuring Competitiveness

None of the studies surveyed above provided measures for national or international competi-

[6] U.S. President's Commission on Industrial Competitiveness, *Global Competition: The New Reality*, 1985.

[7] Dertouzos et al., *Made in America: Regaining the Competitive Edge*, MIT, 1989.

tiveness except for Porter's study which recommended some measures for international competitiveness. Porter uses standard measures, such as share of world exports, export and import levels, and growth and share of total U.S. exports. There are two other studies that have attempted to measure international competitiveness. The Council on Competitiveness located in Washington, D.C. publishes an annual "Competitiveness Report Card and Index."[8] The index is actually four indices covering investment (industry expenditure on plant and equipment as a share of gross domestic product [GDP]), productivity (real GDP per manufacturing employee), trade (merchandise exports), and the standard of living (real GDP per capita). In each case the index measures U.S. performance relative to the G-7 countries (Canada, France, Great Britain, Italy, Japan, and West Germany). These indices do not reflect the impact of regulations, innovation, and R&D expenditures on the output levels of the firms in the economy.

Another international competitiveness indicator is provided by IMD/World Economic Forum.[9] The index is constructed by considering 326 variables chosen to reflect a nation's suitability as a base for competitive firms. These variables include, for example, GDP measures, inflation rates, firms price/earnings ratios, size of banks, and R&D expenditures by sector. The index also attempts to include firms' perceptions about infrastructure adequacy and executives expectations of the growth in long-term employment. These data were obtained by country from a Business Confidence Survey of executives. The index was then computed by associating weights with each variable. The IMD study concluded that overall, the United States ranks second in the G-7 behind Japan, and third out of all countries surveyed. While the IMD's index contains interesting details on social, economic, and political indicators for the countries surveyed, the arbitrary weighting scheme used to compute this index has been criticized in the literature.

Findings of Literature

On the basis of the studies surveyed above, it appears that the mid-1980s represented a turning point in the national debate about competitiveness. Although opinions diverge with respect to how competitiveness can be achieved, there is consensus in the literature regarding the following issues: competitiveness is more than a transitory exchange rate problem which involves macroeconomic fundamentals such as savings and the budget deficit, and that fundamental problems in human resource management, capital mobilization, and technology have resulted in lower productivity in U.S. firms. Further, there is a need to understand competitiveness broadly in terms of the national standard of living. Therefore, a variety of measures must be addressed to determine their individual and collective impact on a nation's competitiveness.

---

[8] Council of Competitiveness, *Competitiveness Index*, 1990, Washington D.C.

[9] World Economic Forum, *The World Competitiveness Report*, 1990, Geneva.

APPENDIX G
ECONOMETRIC RESULTS

For the analysis in chapter 6, the Commission developed an econometric model to test the impact of the external and internal factors on U.S. competitiveness in global communications equipment markets. The measure of competitiveness, the dependent variable, selected for the study was relative export performance (REP) of the United States versus its competitors, the other major equipment producers, in the MEP and NEP markets. The external and internal factors used for both the NEP and MEP markets were annual wages per employee (WAGE), gross fixed capital formation (GFCF), R&D expenditures (R&DEXP), R&D scientists and engineers (R&DSCI), and the foreign exchange rate (FXRATE). An openness index (OPEN) was included for the MEP markets. The basic form of the regression equation is:

$$REP = a + \beta_1 * WAGE + \beta_2 * GFCF + \beta_3 * R\&DEXP + \beta_4 * R\&DSCI + \beta_5 * FXRATE \; [+ \beta_6 * OPEN \text{ for MEP models}]$$

The expected signs of the β_i's were discussed in chapter 6.

Measures of Competitiveness

The measure of competitiveness in the NEP markets is the export performance of a given MEP country relative to that of the United States. Relative export performance is measured as the ratio of imports of SITC group 724 from the MEP country to imports of SITC group 724 from the United States as reported by the NEP country. The dependent variable for the NEP model is as follows:

$$\frac{\text{NEP}_i \text{ imports of SITC group 724 from MEP}_j}{\text{NEP}_i \text{ imports of SITC group 724 from the United States}} \quad (1)$$

There were three measures of competitiveness used as dependent variables for the MEP market analysis. The results for the first two were reported in the text. The third measure is shown as (4) below.

$$\frac{\text{MEP}_i \text{ imports of SITC group 724 from MEP}_j}{\text{MEP}_i \text{ imports of SITC group 724 from the United States}} \quad (2)$$

$$\frac{\text{U.S. exports of SITC group 724 to MEP}_i}{\text{Total U.S. exports of SITC group 724}} \quad (3)$$

$$\frac{\text{MEP}_i \text{ imports of SITC group 724 from the United States}}{\text{MEP}_i \text{ total imports of SITC group 724 from all countries}} \quad (4)$$

After the data had been converted into real dollar terms, they were used to construct ratios that were used in the estimation. A typical NEP regression equation would look as follows:

$$\frac{\text{NEP}_i \text{ imports from MEP}_j}{\text{NEP}_i \text{ imports from the U.S.}} = f\left[\frac{\text{annual wages in MEP}_j}{\text{annual wages in the U.S.}}\right.,$$

$$\frac{\text{gfcf in MEP}_j}{\text{gfcf in the U.S.}}, \frac{\text{R\&D expenditures in MEP}_j}{\text{R\&D expenditures in the U.S.}},$$

$$\left.\frac{\text{R\&D scientists per 10,000 workers in MEP}_j}{\text{R\&D scientists per 10,000 workers in the U.S.}}, \right. \quad (5)$$

$$\text{exchange rate in foreign currency per U.S. dollar}]$$

A typical MEP regression would also look like (5) but would include the openness index as an independent variable. The openness index is used to capture the possible impact of procurement and other, related policies in the MEP markets. The openness index is computed as follows:

$$\frac{\dfrac{\text{MEP}_i \text{ imports of SITC group 724}}{\text{MEP}_i \text{ total imports}}}{\dfrac{\Sigma\text{MEP}_i + \text{U.S. imports of SITC group 724}}{\Sigma\text{MEP}_i + \text{U.S. total imports}}} \qquad (6)$$

Beta Weights

The relative influence of the external and internal factors was of interest in addition to their significance. In order to estimate the relative influence of the factors, beta weights were used. In a regression equation using variables that have been centered and scaled, such as the following

$$\frac{(y-\bar{y})}{\sigma_y} = \beta_x \frac{(x-\bar{x})}{\sigma_x} + \beta_w \frac{(w-\bar{w})}{\sigma_w} \qquad (7)$$

the β_i measure the change in standard deviation units that a one standard deviation change in the independent variable x would have on the dependent variable y holding the independent variable w constant. (See H. Blalock, *Social Statistics*, pp. 477-82). Beta weights are used in this study as the measure of influence that one independent variable, such as relative gross fixed capital formation, has on the dependent variable, relative export performance.

Data, Sources, and Transformations

The data used in the regression analysis are from the Organization for Economic Cooperation and Development (OECD), the International Monetary Fund, and the United Nations.

The Directorate for Science, Technology and Industry of the OECD supplied data on wages, gross fixed capital formation, and R&D expenditures for ISIC 3832, the radio, television, communications equipment, and semiconductor industries. The OECD also furnished data on the number of R&D scientists and engineers in the electrical machinery industry, ISIC 383. These data were both the most disaggregated and the longest time series the Commission could find which were reported on a consistent basis.

The wage, gross fixed capital formation, and R&D expenditure data were converted into real terms by deflating the individual series by a wholesale price index (line 63 from *International Financial Statistics* (IFS)) for the respective MEP country. U.S. data were similarly converted into real terms. The data for Canada, France, Germany, Japan, Sweden, and the United Kingdom were then converted into dollars by using the annual period average exchange rate (series rf from the IFS).

Data were not available for wages in France and gross fixed capital formation in Sweden. When the data for the MEP countries were pooled, France and Sweden were excluded from the regression because of the missing data; however, when regressions were run on individual MEP countries, France and Sweden were included, but the wage and gross fixed capital formation variables were omitted from their respective equations.

Import and export data are from the United Nations data base online at the NIH Computer Center. The dependent variable for the NEP countries was constructed using data on imports of Standard International Trade Classification (SITC), Revised, group 724, Telecommunications Apparatus, as reported by the individual NEP countries. The choice of NEP import data was made to limit the different possible sources of error. First, only one NEP reports the data instead of six MEP countries plus the Untied States. Second, the observation that import data are frequently more accurate since imports are almost always associated with customs duties, and the collection of the correct amount of duty is a corrective force on possible classification errors by exporting countries. Errors in product classification by the exporting countries are especially possible when no export levies are collected by the exporting country. For the MEP market analysis, U.S. export data were used for measure 3, and MEP import data were used for measures 2 and 4 above.

The definition of group 724 is from the SITC, Revised, and includes television receivers; radio receivers; and microphones, loudspeakers, and amplifiers in addition to electrical line telephone and telegraph equipment. The inclusion of the items other than telephone equipment means that the results should be interpreted with care. Most of the non-telephone items are consumer electronic products and U.S. production of such items has declined substantially during the period covered by this study.

Estimation and Evaluation

NEP MODEL

There were four different groups of estimates for the NEP model. These four groups were referred to as estimations 1 through 4 in the text. The regressions were run using the data in level and log form with measure 1 as the dependent variable. The log version performed better than the level version for estimations 1 and 2. Accordingly, the results for the log version were the ones reported in the text. For estimation 3, the levels performed better and those results were used to construct figure 6–9. Estimation 1 was a single regression with all the data pooled. Estimation 2 had 16 regressions, one for each of the 16 NEP markets using pooled data. Estimation 3 had 96 regressions, one for the 16 NEP markets times the 6 MEP competitors. Estimation 4 had 6 regressions, one for each MEP competitor using pooled data. All regressions were done using OLS. The residual plots were examined for the pooled data estimates in 1, 2, and 4 for evidence of hetroskedasticity, but none of the plots exhibited a marked departure from homoskedastistic error terms. Multicollinearity did not appear to be a problem in estimations 1 and 2. The condition index for each regression was less than 30. In estimation 3, the condition indexes ranged from 95 to 155 for the regressions involving Canada, France, Germany, and the United Kingdom; however, for the regressions involving Japan and Sweden, the condition indexes were greater than 400. Belsley, Kuh, and Welsch[1] recommend additional diagnostics for regressions with condition indexes greater than 30; however, operational constraints precluded any further investigation of the possible degradation of the parameter estimates due to multicollinearity. The adjusted R–squares were reported in the text. The results for the NEP model are presented in Table G-1.

MEP MODEL

There were three different sets of estimates for the MEP model. The first measure was estimated for each MEP/U.S. combination into a third MEP market for a total of 30 regressions. The second and third MEP measures each had six regressions and were also estimated with all the data pooled for a single regression. All regressions were done using OLS. Residual plots for the second and third measures using pooled data were checked for hetroskedasticity. Again, the error terms did not appear to depart from a homoskedastistic pattern. When estimating the six separate country equations, measures 2 and 3 had condition indexes that ranged from 140 to 240 indicating multicollinearity may be degrading the estimates, but again, operational constraints precluded further investigation. The condition indexes for measure 1 fell in a similar range. The adjusted R-squares were reported in the text. The results of the MEP model are presented in Table G-2.

The third measure of competitiveness used in the MEP model attempts to explain the export performance of the United States in a given MEP country relative to total imports of communications equipment into that market. This measure reflects how the United States competes in a given MEP market relative to all other foreign suppliers of communications equipment. For this measure, the data for the MEP markets were pooled for a single regression as well as being used for individual regressions for each market. Annual wages, R&D expenditures, and the openness index were significant and had the expected impact for the pooled regression; however, the openness index was the least influential. The amount of variation in the U.S. export performance explained by these factors was about 85 percent. When the MEP countries were treated as individual markets, the external and internal factors were not as successful in explaining U.S. export performance. The level of technical expertise as measured by the number of R&D scientists and engineers was the only factor that was significant and had the expected impact. The third measure of competitiveness explained about 50 to 90 percent of the variation in relative export performance.

---

[1] David Belsley, Edwin Kuh, and Roy Welsch, *Regression Diagnostics*, John Wiley: New York, 1980.

Table G-1: NEP results.

		Constant	Relative wages per employee	Relative gross fixed capital formation	Relative R&D expenditures	Relative R&D scientists and engineers	Foreign exchange rate	R square	F test	DW
Estimation 1										
	Est	-0.1767	-0.26525	0.3908	0.46083	-0.05636	0.27701	0.4452	133.67	0.518
	std err	0.2014	0.20879	0.19522	0.25078	0.27423	0.03199			
Estimation 2										
NEP market:										
Australia	Est	0.9179	-0.18892	1.20259	-0.30458	1.10031	0.24482	0.9179	111.788	1.02
	std err	0.277	0.28811	0.2714	0.34905	0.37779	0.0443			
Brazil	Est	-0.4873	-0.44561	0.4216	0.33691	1.0051	0.25748	0.8	40	1.35
	std err	0.3896	0.40518	0.38168	0.49089	0.53131	0.0623			
Greece	Est	1.9756	-0.9465	-0.34493	2.35255	-2.31	0.15619	0.6326	17.216	0.855
	std err	0.7109	0.73941	0.69653	0.89583	0.96958	0.11369			
Indonesia	Est	-0.1553	-1.34176	-0.52001	1.69981	-1.12623	0.24645	0.7941	37.804	1.78
	std err	0.4324	0.44525	0.40265	0.52094	0.55979	0.06629			
Jordan	Est	2.4498	-1.60559	0.5319	1.38035	1.12906	-0.01964	0.8463	52.869	1.99
	std err	0.4965	0.51263	0.48183	0.62084	0.6809	0.07847			
South Korea	Est	-2.4558	0.20747	0.77585	-0.6168	0.21351	0.60158	0.7251	25.844	1.43
	std err	0.6189	0.64002	0.60341	0.77542	0.85036	0.0984			
Malaysia	Est	1.1105	-0.21057	1.03538	-0.18897	0.62043	0.21466	0.834	50.235	1.06
	std err	0.3669	0.38161	0.35948	0.46234	0.5004	0.05868			
Mexico	Est	-2.2135	0.17836	0.01091	0.65541	-0.21122	0.36773	0.6326	17.221	1.7
	std err	0.47	0.48883	0.46048	0.59224	0.641	0.07516			
New Zealand	Est	0.2334	-0.12038	2.16977	-2.35698	2.30844	0.02065	0.5244	11.025	0.662
	std err	0.6225	0.64742	0.60987	0.78438	0.84895	0.09955			
Philippines	Est	-2.0602	0.35205	-0.62053	1.35669	-2.19366	0.50033	0.5205	10.855	0.704
	std err	0.6303	0.6555	0.61748	0.79417	0.85955	0.10079			
Poland	Est	0.1721	-3.68886	1.50812	0.65612	-5.28297	-0.77918	0.5653	4.162	2.57
	std err	1.4335	1.58563	1.27354	1.33897	1.93161	0.30036			
Saudi Arabia	Est	-0.6221	-1.51899	0.24807	0.84502	-0.77387	0.21216	0.8911	50.722	1.46
	std err	0.4551	0.4633	0.37727	0.49561	0.62344	0.06402			
Spain	Est	1.6549	-0.66967	0.32924	1.52208	-0.18736	0.11927	0.8776	71.691	1.27
	std err	0.3706	0.38542	0.36307	0.46696	0.5054	0.05926			
Thailand	Est	-0.3478	0.02424	0.86779	-0.30732	1.22179	0.54454	0.9386	152.87	2.02
	std err	0.2768	0.28788	0.27118	0.34877	0.37749	0.04426			
Turkey	Est	-0.426	1.89563	-0.38478	-0.1381	-0.05741	0.26983	0.4968	9.874	1.48
	std err	0.508	0.52834	0.4977	0.64011	0.69281	0.08124			
Venezuela	Est	-2.95414	0.61803	1.23745	-0.79354	-0.67455	0.5267	0.8698	66.79	1.32
	std err	0.38057	0.39581	0.37285	0.47954	0.51902	0.06086			

Table G-1: NEP results--(cont.)

Estimation 3 NEP market:	MEP competitor:										
Australia	Canada	Est	-0.3245	0.0093	2.2496	-1.287	0.0384	0.2924	0.8715	12.202	1.76
		std err	0.1623	0.0724	0.6285	0.893	0.0705	0.1176			
	France	Est	-1.2241	-	-0.3327	2.164	2.344	0.0122	0.8249	8.245	2.16
		std err	0.8067	-	0.3342	1.168	0.6034	0.0645			
	Germany	Est	2.3023	-1.6329	1.725	0.244	0.0046	-0.5043	0.9418	12.951	2.39
		std err	1.2168	0.6477	0.6429	1.128	0.4252	0.3148			
	Japan	Est	-28.8118	-27.7446	0.599	8.989	50.0091	0.0464	0.6606	4.282	2.39
		std err	23.2549	23.8088	5.9529	21.427	12.8369	0.058			
	Sweden	Est	-1.3455	0.5535	-	2.271	-0.8335	0.2122	0.3642	1.289	1.84
		std err	0.8503	0.302	-	3.399	0.3813	0.104			
	United Kingdom	Est	-10.7842	4.5825	10.9129	0.482	0.8057	9.1977	0.6954	3.654	2.71
		std err	5.2334	4.7049	5.8601	5.814	2.8882	4.6988			
Brazil	Canada	Est	0.3917	-0.3339	-0.8524	1.711	-0.0591	-0.0361	0.3363	0.912	2.16
		std err	0.6158	0.2746	2.3841	3.388	0.2675	0.4461			
	France	Est	0.3719	-	1.1048	-0.89	-2.527	0.1225	0.7081	4.246	2.49
		std err	1.5784	-	0.6539	2.285	1.1807	0.1262			
	Germany	Est	1.6513	-1.4167	1.7395	0.621	-0.7162	-0.2108	0.7871	2.958	3.17
		std err	2.0969	1.1161	1.1079	1.944	0.7327	0.5425			
	Japan	Est	-5.0858	1.853	1.4584	0.719	2.9467	0.0107	0.6945	5.001	2.86
		std err	2.6974	2.7616	0.6905	2.485	1.489	0.0067			
	Sweden	Est	-8.0189	3.2589	-	23.681	-9.1663	1.3412	0.678	4.738	1.61
		std err	6.4402	2.287	-	25.746	2.8882	0.7879			
	United Kingdom	Est	-0.7277	-0.5784	1.4595	-0.172	1.1851	0.1224	0.7147	4.008	2.04
		std err	0.8266	0.7431	0.9255	0.918	0.4562	0.7421			
Greece	Canada	Est	8.0852	-3.3602	18.1328	-71.143	-0.3643	-1.2891	0.8246	8.462	2.33
		std err	4.2309	1.8867	16.3795	23.279	1.8377	3.065			
	France	Est	2.8834	-	2.6545	-3.456	-7.5937	0.3353	0.3351	0.882	2.2
		std err	10.162	-	4.2098	14.711	7.6013	0.8126			
	Germany	Est	44.7939	23.6205	24.7903	-177.247	52.7546	-15.9394	0.7844	2.911	2.22
		std err	81.7983	43.5374	43.2203	75.85	28.583	21.1614			
	Japan	Est	36.9083	-39.4517	9.0353	-36.248	25.6342	-0.104	0.3424	1.145	2.93
		std err	27.447	28.1008	7.026	25.29	15.151	0.0685			
	Sweden	Est	-4.9655	1.8251	-	-18.145	-0.9165	0.6792	0.7048	5.372	2.31
		std err	2.9366	1.0428	-	11.739	1.3169	0.3593			
	United Kingdom	Est	-2.8204	5.2866	-0.3092	-4.021	-0.8178	3.8137	0.5142	1.693	2.83
		std err	2.5934	2.3315	2.9039	2.881	1.4312	2.3284			
Indonesia	Canada	Est	-1.685	0.5237	1.6921	5.329	-0.519	1.077	0.1671	0.361	2.59
		std err	1.977	0.8816	7.6538	10.878	0.8587	1.4322			
	France	Est	9.1232	-	-3.2639	-10.421	-2.6895	-0.6504	0.1907	0.412	2.26
		std err	7.1014	-	2.9419	10.28	5.3119	0.5678			
	Germany	Est	-17.6521	5.7316	9.4533	0.909	0.42	5.1402	0.7663	2.624	3.43
		std err	7.4471	3.9637	3.9349	6.906	2.6022	1.9266			
	Japan	Est	28.5675	-6.6277	-7.7368	0.88	-13.5641	-0.0416	0.6049	3.062	2.02
		std err	16.6572	17.9554	4.2833	14.365	8.559	0.0428			
	Sweden	Est	2.1584	-0.4328	-	0.069	-0.8669	-0.1519	0.4309	1.703	1.82
		std err	3.038	1.0788	-	12.145	1.3624	0.3717			
	United Kingdom	Est	0.1046	3.2169	-2.3996	-2.082	-1.2847	0.6441	0.3682	0.933	2.59
		std err	2.183	1.9625	2.4444	2.425	1.2047	1.96			

Table G-1: NEP results--(cont.)

Jordan	Canada	Est	-0.2324	-0.0586	-0.6473	3.074	-0.1643	0.2421	0.489	1.722	2.2
		std err	0.3043	0.1357	1.1779	1.674	0.1322	0.2204			
	France	Est	1.0812	-	-4.1281	4.181	-18.844	1.3709	0.5655	2.278	2.38
		std err	22.1248	-	9.1656	32.029	16.5496	1.7691			
	Germany	Est	-6.8839	4.01	-0.8814	1.59	1.1066	1.8893	0.785	2.92	2.89
		std err	3.4715	1.8477	1.8343	3.219	1.2131	0.8981			
	Japan	Est	-21.4095	35.2061	16.6514	-15.621	-7.9645	0.0502	0.4388	1.72	2.38
		std err	40.9676	41.9435	10.4871	37.748	22.6145	0.1022			
	Sweden	Est	-2.1878	0.6479	-	-4.2	-0.1004	0.2836	0.752	6.824	2.18
		std err	1.4645	0.5201	-	5.855	0.6568	0.1792			
	United Kingdom	Est	-9.8946	8.0318	4.7598	-1.462	-1.1662	11.0281	0.5081	1.653	2.72
		std err	4.9411	4.4421	5.5328	5.489	2.7269	4.4364			
South Korea	Canada	Est	-0.9965	1.1533	20.7341	-22.967	1.4073	-0.3517	0.4013	1.207	2.77
		std err	2.8551	1.2732	11.0531	15.709	1.2401	2.0683			
	France	Est	-0.3062	-	0.2426	0.481	0.2139	0.0143	0.6965	4.016	2.43
		std err	0.3287	-	0.1362	0.476	0.2459	0.0263			
	Germany	Est	-1.2817	0.1234	0.9943	1.233	-0.409	0.4102	0.7278	2.138	2.28
		std err	1.1586	0.6167	0.6122	1.074	0.4049	0.2997			
	Japan	Est	34.7559	-41.8269	-2.6852	-16.297	19.131	-0.0848	0.4577	1.857	1.63
		std err	25.7836	26.3978	6.6002	23.757	14.2328	0.0643			
	Sweden	Est	-1.0904	0.3573	-	-2.806	-0.1251	0.1401	0.8694	14.973	2.1
		std err	0.397	0.141	-	1.587	0.178	0.0486			
	United Kingdom	Est	0.5674	1.3244	-1.1917	-1.757	-0.5182	-0.3599	0.2383	0.501	2.88
		std err	1.3128	1.1802	1.47	1.458	0.7245	1.1787			
Malaysia	Canada	Est	-0.7645	-0.1484	1.3598	0.775	-0.2731	0.9915	0.5602	2.293	2.67
		std err	1.0421	0.4647	4.0343	5.734	0.4526	0.7549			
	France	Est	2.1339	-	-0.7667	-2.628	-1.1319	-0.1175	0.2889	0.711	2.43
		std err	1.5637	-	0.6478	2.264	1.1697	0.125			
	Germany	Est	-8.7954	4.4276	6.8595	1.954	-0.1872	1.9543	0.8859	6.211	2.83
		std err	5.8656	3.122	3.0992	5.439	2.0496	1.5174			
	Japan	Est	57.0921	-19.3576	0.7609	-13.936	-25.183	-0.1004	0.7277	5.879	2.5
		std err	15.8379	16.2152	4.0543	14.593	8.7427	0.0395			
	Sweden	Est	-7.9349	7.8803	-	-169.415	-9.7399	1.6363	0.7804	7.996	1.54
		std err	11.8528	4.2091	-	47.383	5.3155	1.4501			
	United Kingdom	Est	4.3452	5.7352	-1.3148	-12.624	1.0033	-7.5703	0.9107	16.321	2.92
		std err	3.092	2.7797	3.4622	3.435	1.7064	2.7761			
Mexico	Canada	Est	-0.0645	-0.031	-0.3648	1.314	-0.0802	0.0951	0.2867	0.724	2.29
		std err	0.1673	0.0746	0.6477	0.921	0.0727	0.1212			
	France	Est	0.3598	-	0.2617	-0.281	-0.1546	-0.0309	0.5285	1.961	1.45
		std err	1.0224	-	0.4236	1.48	0.7648	0.0818			
	Germany	Est	1.7723	-1.62	-0.2055	2.318	-0.3686	-0.3632	0.8646	5.109	2.55
		std err	0.9373	0.499	0.4952	0.869	0.3275	0.2425			
	Japan	Est	-1.8697	-0.271	0.1975	0.286	1.9552	0.0037	0.3472	1.17	1.63
		std err	1.7724	1.815	0.4537	1.633	0.9784	0.0044			
	Sweden	Est	2.4184	-0.266	-	16.658	-2.7943	-0.0849	0.4243	1.659	1.38
		std err	7.5416	2.678	-	30.149	3.3821	0.9226			
	United Kingdom	Est	0.0472	-0.238	-0.0166	0.526	-0.2804	0.3892	0.3605	0.902	2.71
		std err	0.5174	0.465	0.5794	0.575	0.2856	0.4646			

Table G-1: NEP results--(cont.)

New Zealand	Canada	Est	1.5759	-0.606	8.9997	3.347	1.7325	-1.7856	0.6079	2.79	2.89
		std err	2.6883	1.199	10.4074	14.791	1.1676	1.9475			
	France	Est	2.7146	-	-0.7363	-5.138	-1.2495	-0.0813	0.6562	3.34	3.09
		std err	3.3094	-	1.371	4.791	2.4755	0.2646			
	Germany	Est	-1.9744	0.848	0.0908	0.638	0.6824	0.396	0.7658	2.615	2.61
		std err	0.7988	0.425	0.4221	0.741	0.2791	0.2067			
	Japan	Est	2.5636	-40.455	4.9964	-4.821	35.7279	-0.0233	0.5841	3.09	2.1
		std err	17.0919	17.499	4.3753	15.748	9.4349	0.0427			
	Sweden	Est	0.2733	0.157	-	-9.036	-0.34	0.0154	0.42	1.629	2.68
		std err	1.4049	0.499	-	5.616	0.63	0.1719			
	United Kingdom	Est	47.1276	-39.624	24.3598	-37.672	37.4592	-79.2694	0.8958	13.754	1.88
		std err	18.7139	16.824	20.9548	20.79	10.3277	16.8022			
Philippines	Canada	Est	2.5491	-0.458	-7.6888	9.87	0.2574	-2.0331	0.5911	2.602	1.98
		std err	1.3269	0.592	5.1368	7.301	0.5763	0.9612			
	France	Est	0.0901	-	-0.0103	-0.169	-0.0176	-0.0051	0.6023	2.65	2.11
		std err	0.0715	-	0.0296	0.103	0.0535	0.0057			
	Germany	Est	5.7196	5.621	-1.4702	-22.288	2.1046	-1.4259	0.824	3.745	2.95
		std err	8.1869	4.358	4.3258	7.592	2.8608	2.118			
	Japan	Est	9.3967	-14.142	1.5473	-0.549	4.0088	-0.0248	0.4757	1.996	1.7
		std err	4.9264	5.044	1.2611	4.539	2.7194	0.0123			
	Sweden	Est	5.899	-0.261	-	-63.687	-1.8555	-0.339	0.2314	0.678	2.83
		std err	17.6625	6.272	-	70.609	7.9209	2.1608			
	United Kingdom	Est	0.6135	-0.783	-0.0657	0.674	-0.0836	-0.3296	0.3743	0.957	1.83
		std err	0.5298	0.476	0.5933	0.589	0.2924	0.4757			
Poland	Canada	Est	-	-	-	-	-	-	-	-	-
		std err									
	France	Est	-1.7142	-	1.5381	3.537	3.4031	-0.0113	0.3917	0.322	3.07
		std err	10.3535	-	17.7341	13.369	8.7321	0.9219			
	Germany	Est	11.0769	28.927	-38.8901	-55.848	27.6282	-8.2461	0.4012	0.134	3.16
		std err	89.4857	157.739	69.2442	402.013	57.0264	22.7106			
	Japan	Est	-85.269	90.942	6.0557	-48.184	33.5529	0.1735	0.8337	1.003	2.28
		std err	97.815	104.455	9.0791	57.099	32.985	0.2324			
	Sweden	Est	-	-	-	-	-	-	-	-	-
		std err									
	United Kingdom	Est	-	-	-	-	-	-	-	-	-
		std err									
Saudi Arabia	Canada	Est	-0.8194	0.1882	-2.634	5.007	-0.3167	0.5881	0.8162	3.552	2.43
		std err	0.4559	0.1937	1.189	2.405	0.1451	0.2429			
	France	Est	3.7138	-	-1.391	-3.864	-2.9649	-0.1497	0.5832	1.749	3.09
		std err	2.0001	-	0.776	2.55	1.4332	0.145			
	Germany	Est	2.6509	0.2006	0.589	-3.219	-1.3569	-0.4195	0.7289	1.075	3.24
		std err	3.32	1.4639	1.365	2.039	0.7979	0.8542			
	Japan	Est	10.0904	-5.3715	-4.422	19.959	-13.8267	0.0033	0.7382	2.82	2.73
		std err	21.5941	23.9451	3.117	11.128	9.064	0.0589			
	Sweden	Est	3.382	-3.0627	-	86.56	3.1571	-0.5768	0.8461	6.874	1.91
		std err	3.489	1.2015	-	18.284	1.4756	0.4069			
	United Kingdom	Est	-2.6278	0.7032	4.893	-0.829	1.4662	0.9071	0.8982	7.055	3.01
		std err	2.0604	1.972	2.02	2.203	1.3515	2.5485			

Table G-1: NEP results--(cont.)

Spain	Canada	Est	-0.6477	0.1482	1.337	0.542	-0.2013	0.4908	0.3778	1.093	2.81
		std err	0.3262	0.1455	1.263	1.795	0.1417	0.2363			
	France	Est	-2.1464	-	1.204	3.502	-0.1364	0.2647	0.5273	1.952	2.14
		std err	1.3966	-	0.579	2.022	1.0447	0.1117			
	Germany	Est	-2.8594	0.7454	2.386	3.934	-0.9469	1.0695	0.7909	3.026	2.77
		std err	3.3156	1.7647	1.752	3.075	1.1586	0.8578			
	Japan	Est	-3.7372	4.9317	1.297	-6.79	7.0537	0.0038	0.7386	6.217	1.99
		std err	5.7494	5.8864	1.472	5.298	3.1737	0.0143			
	Sweden	Est	-2.0544	1.7023	-	-18.913	-4.1107	0.5129	0.6977	5.193	2.53
		std err	3.8639	1.3721	-	15.447	1.7328	0.4727			
	United Kingdom	Est	0.6033	-3.8373	3.434	3.051	1.6072	-1.118	0.5394	1.874	2.44
		std err	1.9111	1.7181	2.14	2.123	1.0547	1.7159			
Thailand	Canada	Est	-0.4003	0.1717	1.35	-1.343	0.2086	0.1747	0.5567	2.26	2.49
		std err	0.5541	0.2471	2.145	3.049	0.2407	0.4014			
	France	Est	-0.717	-	-0.128	1.216	-0.2036	0.11	0.3711	1.033	3.27
		std err	1.9697	-	0.816	2.851	1.4734	0.1575			
	Germany	Est	0.807	-1.1925	-0.076	1.587	0.9993	-0.227	0.7632	2.578	2.52
		std err	1.6239	0.8643	0.858	1.506	0.5675	0.4201			
	Japan	Est	-3.844	2.6529	15.06	-19.747	8.4306	0.0047	0.3902	1.408	1.8
		std err	29.6832	30.3902	7.598	27.35	16.3854	0.0741			
	Sweden	Est	-6.7235	3.3356	-	-57.675	2.8886	0.6749	0.3682	1.311	2.28
		std err	10.8349	3.8476	-	43.314	4.859	1.3256			
	United Kingdom	Est	-0.2026	0.5525	0.193	-0.955	0.1409	0.1405	0.4868	1.517	2.71
		std err	0.5994	0.5029	0.626	0.621	0.3087	0.5023			
Turkey	Canada	Est	10.1237	-18.0746	-191.221	242.029	-26.7842	18.9231	0.4415	1.423	2.69
		std err	30.0964	13.421	116.515	165.594	13.0722	21.803			
	France	Est	-0.156	-	-0.85	1.405	-0.2541	0.0526	0.3993	1.163	1.49
		std err	1.8109	-	0.75	2.622	1.3546	0.1448			
	Germany	Est	3.6754	9.996	9.766	-27.084	-5.778	-0.1922	0.4252	0.592	3.14
		std err	25.5008	13.5729	13.474	23.646	8.9108	6.5971			
	Japan	Est	-6.7959	-2.0834	1.712	8.517	2.8118	0.0138	0.6348	3.825	1.69
		std err	5.912	6.0528	1.513	5.447	3.2635	0.0148			
	Sweden	Est	2.53491	-0.22617	-	-22.0485	0.84867	-0.2901	0.4838	2.109	2.14
		std err	2.68371	0.95303	-	10.7286	1.20354	0.32833			
	United Kingdom	Est	2.24928	4.86648	-5.30057	-5.814	-1.75398	-1.45078	0.3037	0.698	2.23
		std err	3.69191	3.31905	4.13399	4.1015	2.03747	3.31477			
Venezuela	Canada	Est	0.89455	-0.46218	-0.77521	1.6714	-0.09947	-0.36352	0.7957	7.01	1.76
		std err	0.24394	0.10878	0.94439	1.3422	0.10595	0.17672			
	France	Est	0.31925	-	-0.01438	-0.577	0.07195	-0.02856	0.6463	3.198	2.54
		std err	0.13068	-	0.05414	0.1892	0.09775	0.01045			
	Germany	Est	-0.57057	-0.38668	1.4299	0.9754	-0.74578	0.32305	0.8519	4.602	3.13
		std err	1.00937	0.53724	0.53333	0.936	0.35271	0.26113			
	Japan	Est	-0.81694	-4.2011	0.44095	-0.3356	4.6576	0.00143	0.6507	4.098	2.13
		std err	2.17533	2.22715	0.55685	2.0044	1.20081	0.00543			
	Sweden	Est	-2.42781	1.85266	-	-29.4118	-2.06684	0.39523	0.5825	3.139	2.63
		std err	3.70845	1.31693	-	14.8252	1.6631	0.4537			
	United Kingdom	Est	0.17206	-0.03579	0.00722	-0.1863	-0.01194	-0.13431	0.6506	2.979	2.77
		std err	0.18298	0.1645	0.20489	0.2033	0.10098	0.16429			

Table G-1: NEP results--(cont.)

Estimation 4										
MEP										
competitor:										
Canada	Est	0.0213	-3.56134	-0.3067	1.58941	-1.16235	0.09544	0.0146	0.623	0.608
	std err	2.9794	2.63581	0.97925	1.74437	1.57364	5.26386			
France	Est	-2.6977	-	-0.93628	-1.59316	-0.45277	-2.00585	0.044	2.073	0.474
	std err	2.8137	-	1.14211	2.30205	2.02799	4.00393			
Germany	Est	-0.2107	0.49841	0.35148	-0.14872	0.52582	0.50362	0.0057	0.169	0.295
	std err	2.478	3.93466	0.84835	1.67917	1.65532	6.39511			
Japan	Est	9.2312	-1.64559	0.07149	0.04282	2.01271	-1.64578	0.0223	1.135	0.506
	std err	8.0317	1.15597	0.32992	0.58584	1.0799	1.60243			
Sweden	Est	0.3643	-1.65997	-	-0.96713	-0.4097	-3.02936	0.0268	1.411	0.514
	std err	21.6754	7.21601	-	1.2425	1.32071	9.55964			
United	Est	-2.3767	0.55257	0.22495	-0.74344	0.00032	-0.45873	0.0224	0.942	0.493
Kingdom	std err	3.7799	2.18821	1.32331	0.7948	1.65873	2.19326			

Note: Est is parameter estimate. Std err is the standard error.
Source: Staff of the U.S. International Trade Commission.

Table G-2: MEP results.

			Constant	Relative wages per employee	Relative gross fixed capital formation	Relative R&D expenditures	Relative R&D scientists & engineers	Foreign exchange rate	Openness index	R square	F test	DW
Measure 1												
MEP competitor:	MEP market:											
Canada	France	Est	-0.0045	-0.0383	-0.68028	1.3627	-0.0523	0.04472	-0.00583	0.6978	3.079	1.92
		std err	0.1302	0.0635	0.37709	0.5494	0.0521	0.09673	0.03923			
	Germany	Est	-0.2177	0.1633	-2.06521	0.3283	-0.0261	0.26376	-0.14297	0.7821	4.787	2.08
		std err	0.4066	0.1981	1.44242	2.0904	0.1821	0.30989	0.11857			
	Japan	Est	0.188	-0.0432	0.29235	-0.6806	0.0745	-0.12436	-0.03768	0.9085	13.232	2.38
		std err	0.0399	0.0197	0.15037	0.2198	0.017	0.0298	0.05522			
	Sweden	Est	-0.0189	0.0239	0.47236	-3.3987	-0.2153	0.42223	-0.14637	0.3677	0.775	2.06
		std err	0.9281	0.3978	3.42656	4.7645	0.3887	0.67059	0.23577			
	United Kingdom	Est	0.096	-0.0135	-4.0238	2.7841	-0.0252	-0.01744	0.10693	0.8044	5.484	1.74
		std err	0.3895	0.1738	1.5127	2.1493	0.17	0.28661	0.06335			
France	Canada	Est	0.0116		-0.00368	0.0034	-0.0031	-0.00014	-0.0044	0.282	0.471	2.65
		std err	0.0124		0.00405	0.0135	0.0087	0.00073	0.00503			
	Germany	Est	-0.7171		2.48831	2.1786	2.1663	0.0254	-0.36464	0.4391	0.939	1.05
		std err	6.5629		2.2953	8.6815	4.5647	0.44624	4.25438			
	Japan	Est	0.0831		0.01539	-0.0863	-0.0477	-0.00461	-0.04705	0.7535	3.668	2.57
		std err	0.0692		0.02285	0.0911	0.0471	0.00548	0.1063			
	Sweden	Est	0.5504		0.63954	-1.0244	0.286	-0.03174	-0.17822	0.4552	1.003	2.36
		std err	0.7805		0.64353	1.1224	0.6322	0.06221	0.3849			
	United Kingdom	Est	1.7		-0.44824	-0.8267	-0.7947	-0.07559	-0.38961	0.8174	5.37	3.18
		std err	0.6476		0.27954	0.8215	0.4464	0.04593	0.14904			
Germany	Canada	Est	-0.089	0.0285	0.05872	0.021	0.0012	0.02522	0.00232	0.9968	411.714	2.84
		std err	0.0033	0.0018	0.00176	0.0036	0.0017	0.00092	0.00134			
	France	Est	7.2116	-3.0327	2.43994	-4.5817	1.0072	-1.66515	2.51393	0.8832	3.781	2.76
		std err	6.0664	2.1588	2.93267	6.4007	5.0549	1.04795	6.08428			
	Japan	Est	0.9977	-0.1271	0.14802	-0.3998	0.037	-0.2044	-1.87793	0.8652	3.208	3.38
		std err	0.7878	0.2558	0.13398	0.2278	0.1055	0.17581	1.10498			
	Sweden	Est	7.2048	-4.4445	-1.40274	-1.4908	-2.6939	-2.31487	5.64662	0.9671	14.685	2.25
		std err	3.2248	1.7038	2.95655	3.0226	1.177	1.05478	1.71825			
	United Kingdom	Est	3.6398	-1.7019	-1.72772	1.4595	0.4281	-0.81885	0.1828	0.3497	0.269	2.73
		std err	3.707	1.7504	1.5788	3.9836	1.1865	0.79639	1.21709			
Japan	Canada	Est	-0.0758	-1.2103	0.43378	-0.2384	0.9689	-0.00038	0.22077	0.548	2.021	1.75
		std err	1.0034	0.6634	0.20096	0.6176	0.3407	0.0018	0.28332			
	France	Est	-2.1948	1.4415	0.41309	3.5225	0.5856	0.00125	2.53479	0.8927	13.871	1.6
		std err	2.9371	3.514	1.04966	2.7369	1.6023	0.00796	1.29776			
	Germany	Est	16.3287	-8.9316	-1.09945	-14.741	11.1267	-0.03403	-3.05483	0.647	3.054	1.43
		std err	8.8373	9.5065	3.55243	8.4184	4.8035	0.02208	4.09335			
	Sweden	Est	1.8262	-11.7057	-0.71023	8.3628	7.9533	-0.01384	2.67221	0.6302	2.84	2.15
		std err	7.7198	7.8854	1.97141	7.1184	4.5189	0.02035	1.8892			
	United Kingdom	Est	8.7565	-7.1655	1.1275	-15.396	8.0489	-0.02979	2.6515	0.7608	5.302	1.93
		std err	8.9872	6.8771	1.68619	5.5668	3.5487	0.01923	1.6731			

Table G-2: MEP results--(cont.)

Sweden	Canada	Est	0.0568	0.0016		-0.3685	-0.0443	-0.00093	-0.00722	0.8668	10.409	1.81
		std err	0.0668	0.0157		0.2001	0.0207	0.00624	0.02015			
	France	Est	-0.0324	0.0565		-10.7404	1.1703	-0.08455	0.65922	0.709	3.898	1.87
		std err	1.1915	0.4144		11.4558	0.5364	0.1434	1.04744			
	Germany	Est	-1.91168	0.70752		-1.0903	-0.39809	0.20911	0.18906	0.6077	2.478	1.08
		std err	0.88366	0.31121		4.62	0.39802	0.10713	0.37587			
	Japan	Est	0.04839	-0.00777		0.027	0.03023	-0.00556	-0.07508	0.6186	2.595	2.43
		std err	0.03589	0.01258		0.1608	0.01653	0.00433	0.04772			
	United Kingdom	Est	-0.30156	0.69192		-23.4226	-0.06949	0.03917	0.32922	0.6875	3.52	2.08
		std err	1.81456	0.62649		6.9648	0.80505	0.2164	0.26803			
United Kingdom	Canada	Est	-0.02439	0.00815	0.11438	-0.0212	0.01056	0.00633	0.01679	0.9675	34.708	3.12
		std err	0.06282	0.03179	0.04502	0.0395	0.02361	0.03755	0.02116			
	France	Est	1.20829	0.17278	-1.19306	-0.9037	-0.18639	-0.36875	0.25753	0.9137	12.357	3.06
		std err	0.28772	0.25854	0.3241	0.7412	0.30381	0.45696	0.30206			
	Germany	Est	-0.08083	-2.84788	1.91194	2.4277	1.24016	-0.59264	1.02387	0.5076	1.203	1.47
		std err	1.56937	1.47041	1.75583	2.3083	1.27784	1.79846	1.03347			
	Japan	Est	0.32962	-0.03348	-0.09996	0.4413	-0.39234	0.18813	-0.72709	0.8799	8.545	2.5
		std err	0.21665	0.19671	0.24773	0.2888	0.12244	0.21768	0.39946			
	Sweden	Est	-1.15207	0.16844	2.12565	-4.865	2.30821	-2.23992	2.31801	0.9273	14.879	1.92
		std err	2.01373	1.99925	2.3441	2.2129	1.38567	2.19238	1.1084			
Measure 2												
All MEPs		Est	-0.02203	0.0603	0.02299	-0.10158	-0.01265	0.0002	0.09085	0.8007	32.807	0.665
		std err	0.0294	0.028	0.02852	0.04919	0.02216	0.00006	0.0279			
Individual MEPs:												
Canada		Est	1.40151	-0.3512	-0.76689	-1.2153	0.03275	-0.61914	-0.10747	0.9586	30.867	2.17
		std err	0.19443	0.05963	0.63061	0.74052	0.06073	0.10498	0.05968			
France		Est	0.03904		0.00971	-0.01039	-0.04361	0.00033	-0.00154	0.9066	11.654	2.62
		std err	0.02417		0.00595	0.02141	0.0121	0.00148	0.02054			
Germany		Est	0.19814	-0.01221	-0.0655	0.23486	-0.16383	0.00177	-0.12082	0.9521	9.937	3.06
		std err	0.10158	0.03594	0.03396	0.10118	0.06304	0.01627	0.07599			
Japan		Est	0.12076	-0.16339	0.00749	0.11817	-0.01804	-0.00018	0.05151	0.5087	1.725	1.72
		std err	0.10674	0.11872	0.02612	0.09659	0.05359	0.0003	0.14606			
Sweden		Est	-0.0184	0.00395		0.14603	0.00071	0.00201	0.00446	0.5818	2.226	3.16
		std err	0.01876	0.00753		0.07567	0.01065	0.00246	0.00501			
United Kingdom		Est	0.06695	0.1101	-0.0846	-0.18048	0.01965	-0.05748	0.01811	0.7984	4.62	2.41
		std err	0.07413	0.05712	0.07308	0.08308	0.03346	0.06837	0.02296			

Table G-2: MEP results--(cont.)

Measure 3											
All MEPs	Est	-0.45132	0.631	0.42416	-1.23809	0.30012	0.00251	0.20423	0.8847	62.657	1.13
	std err	0.11453	0.10908	0.11111	0.19162	0.0863	0.00022	0.10866			
Individual MEPs:											
Canada	Est	0.46145	-0.17831	-1.20631	2.45539	-0.36165	0.26397	0.07668	0.5602	1.699	2.81
	std err	0.60384	0.18519	1.95845	2.29981	0.18859	0.32603	0.18534			
France	Est	-0.00064		0.07145	0.20474	-0.10656	0.01418	-0.04274	0.9296	15.843	1.47
	std err	0.05875		0.01448	0.05206	0.02943	0.00359	0.04994			
Germany	Est	0.31391	0.04331	-0.10403	-0.15743	-0.1318	-0.02304	-0.10249	0.9484	9.189	2.59
	std err	0.17912	0.06338	0.05988	0.1784	0.11116	0.0287	0.13398			
Japan	Est	1.06069	-0.0493	0.13513	0.05766	-0.9967	-0.00057	0.87452	0.6407	2.972	1.87
	std err	0.89637	0.99703	0.21938	0.81119	0.45005	0.00249	1.22658			
Sweden	Est	0.07997	-0.00477		0.85126	0.10571	-0.00138	-0.07819	0.954	33.188	2.84
	std err	0.08705	0.03495		0.35114	0.04941	0.01144	0.02324			
United Kingdom	Est	-0.25696	0.22109	0.18231	0.06053	-0.026	0.45155	-0.05033	0.5636	1.507	2.17
	std err	0.30345	0.23381	0.29915	0.34009	0.13696	0.27987	0.09399			

Note: Est is parameter estimate. Std err is the standard error.
Source: Staff of the U.S. International Trade Commission.