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5 U.S.-Japan Telecommunications Trade Conflicts: The Role of Regulation

Andrew R. Dick

For more than fifteen years, the telecommunications equipment sector has played a prominent role in straining trade relations between the United States and Japan. The industry's most recent trade dispute was precipitated by Motorola's charge that technical standards effectively barred its entry into Japan's cellular telephone market. Cellular systems face the technical challenge of transferring calls as customers roam from one company's cells to another. In both the United States and Japan, this challenge was solved by establishing regulatory standards to ensure compatibility among local service providers. However, compatibility did not extend internationally between the United States operating standard (developed jointly by Motorola and AT&T) and the Japanese standard (developed by Nippon Telephone and Telegraph [NTT]). While Japanese cellular companies surmounted the U.S. standards barrier by modifying their equipment for export, Motorola's entry strategy into Japan relied instead on lobbying for market access guarantees under U.S. trade law.

After contentious and prolonged negotiations between the office of the U.S. trade representative (USTR) and the Ministry of International Trade and Industry (MITI), a compromise was reached in 1987. Japan agreed to license Motorola with a local partner (Daini-Denden [DDI]) to supply cellular service outside the Tokyo-Nagoya corridor using Motorola's standard. The Tokyo-Nagoya corridor would be served by Nippon Idou Tsushin (IDO) operating on NTT's standard, and NTT itself would offer cellular service throughout Japan. Motorola originally accepted this compromise but by 1989 had reasserted its claim of market access barriers by arguing that its cellular system remained

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The analysis and conclusions presented in this paper do not purport to reflect those of the U.S. Department of Justice. For their valuable comments, the author thanks Takatoshi Ito, Ed Leamer, Lionel Olmer, and NBER conference participants. UCLA's Center for American Politics and Public Policy kindly provided research support.

disadvantaged because it was not fully portable within Japan. Under renewed pressure from the USTR and Japan's Ministry of Posts and Telecommunications, IDO and NTT agreed to cede radio spectrum for Motorola service in the Tokyo-Nagoya corridor. In 1993, the United States extracted additional spectrum concessions that gave Motorola and NTT equal population coverage, effectively nullifying NTT's ten-year head start in its local market.

The market access charges raised during the cellular dispute were not unfamiliar to the industry. Once telecommunications equipment began trading internationally in volume beginning in the late 1970s, the industry attracted ongoing congressional scrutiny. In 1979, a congressional task force charged Japan with "using their protected home market to improve their telecommunications technology while exporting as much as they can into the open American market" (U.S. Congress 1979, 33). Responding to congressional pressure, the USTR began negotiations with Japan in 1981, seeking to stem the widening bilateral trade imbalance. These early negotiations yielded few tangible results, however, and exports to Japan remained almost level, while imports continued nearly to double annually. In 1985, the United States elevated the dispute by including telecommunications equipment in the Market-Oriented Sector-Selective (MOSS) talks. Despite this renewed negotiating pressure, however, the bilateral imbalance continued to widen. The apparent failure of negotiations finally culminated in the passage of the Telecommunications Trade Act of 1988, which authorized the USTR to impose unilateral sanctions against trading partners for "unfair trade practices" in the industry. Motorola was among the first to use the act as a credible threat for pressing its market access demands in the cellular telephone dispute.

Political rhetoric and policy demands notwithstanding, the American and Japanese telecommunications equipment industries historically have been highly similar in their structures and openness to trade. In 1978, despite congressional claims of unequal market access, *both* countries remained tightly closed. Imports represented less than 5 percent of domestic equipment purchases in both markets, and the United States actually held a larger share of the Japanese market (3.4 percent) than Japan did in the United States (1.2 percent) (*Japan Electronics Almanac* 1984; *U.S. Industrial Outlook* 1980). If, as U.S. trade negotiators asserted, Japan had been pursuing a policy of import protection as export promotion during this period, there is nothing in the market share data to suggest that this strategy had been successful.[1]

Not until the early 1980s, as telecommunications markets were deregulated globally, did persistent imbalances emerge in market penetration. By 1992, once deregulation was effectively concluded in the United States and Japan, import penetration in the United States had grown sixfold to 30.5 percent, and

1. Krugman (1984) demonstrates how import protection in a decreasing-cost industry can raise firms' export market share by guaranteeing them a secure domestic market. However, Dick (1994) finds no supporting evidence for a wide cross section of decreasing-cost industries in the United States.

Japan's share of U.S. telecommunications equipment purchases had risen eightfold to 9.8 percent (*Japan Electronics Almanac* 1994; *U.S. Industrial Outlook* 1994). By comparison, import penetration in Japan had risen only modestly to 5.9 percent, with U.S. shipments continuing to account for less than 5 percent of Japanese imports. Trade policy—in the traditional sense—appears unlikely to have played a major role in generating these imbalances. Tariff rates on telecommunications equipment historically have been low and relatively uniform in the two countries, and U.S. firms have not regarded Japanese nontariff charges on imports as a serious impediment to market access.[2]

An alternative explanation for telecommunications equipment trade patterns is suggested by the "industrial organization approach to international trade." The central insight of that literature is to acknowledge that foreign trade flows are influenced by the domestic market's structure and the form of contractual relations among firms.[3] Historically, telecommunications markets in the United States and Japan (and in most other industrialized countries) were organized around domestic monopoly suppliers of telephone service. These firms either produced their own equipment directly through a wholly owned subsidiary, as in the case of AT&T and Western Electric, or purchased their equipment from a small family of preferred suppliers, as in the case of Japan's NTT and NEC.[4] In both countries, the historically small number of equipment suppliers, combined with their preferential procurement ties to service carriers, were the direct outgrowth of economic and regulatory "barriers to entry" that shaped the industry's structure and organization.

In this paper, I define a barrier to entry to exist in an industry if economic fundamentals or policy choices (i) allow only a small number of suppliers to coexist in the market or (ii) favor preferential, long-term contracts over competitive, arm's-length transactions. The United States and Japan erected regulatory barriers to entry in telecommunications by directly barring competition from independent equipment producers and by indirectly encouraging monopoly service carriers to tightly control equipment distribution within their network. For particular categories of equipment, these regulatory barriers were reinforced by economic barriers to entry. Economic barriers arose naturally from economies to scale (on the supply side) and network economies (on the demand side) and served both to limit the sustainable number of suppliers and to discourage arm's-length sourcing. Common economic and regulatory barriers generated highly similar market structures and contracting practices in the

2. Post–Tokyo Round tariff rates on U.S. imports of telecommunications products ranged from 0.4 to 6.0 percent. Tariff rates in Japan ranged from 4.5 to 9.2 percent (U.S. International Trade Commission 1984, tables 1 and 3). In a 1984 survey by the International Trade Commission of U.S. telecommunications equipment producers, only two respondents of fifty-three cited Japanese nontariff charges on imports as an important barrier to trade (U.S. International Trade Commission 1984, table F1).

3. Important summary references include Helpman and Krugman (1985, 1989).

4. The Nippon Electronic Corp. was the head of NTT's small equipment supply family.

United States and Japan and effectively curtailed trade in telecommunications equipment for both countries until the late 1970s.

During the next decade, deregulation in both countries gradually exposed telecommunications monopolies to competition, and what followed was a complete restructuring of the equipment market and contracting practices.[5] These changes coincided with three major transformations in telecommunications equipment trade patterns. First, with little correlation to trends in total merchandise, durable goods, or advanced technology trade balances, the United States abruptly began a persistent trade deficit in telecommunications equipment after 1982. Second, this trade deficit emerged in both "low-technology" and "high-technology" product segments, although the deficits' timing and persistence varied distinctly within the industry. Finally, these changes initially were unique to the United States and were driven primarily by trade with Japan. Only later were they repeated in U.S.-Asian and European-Japanese trade patterns.

The central question addressed by this paper is the role that deregulation played in first precipitating and then ultimately sustaining the U.S.-Japan trade imbalance in telecommunications equipment. Adopting the industrial organization approach to international trade, the paper assesses how foreign trade patterns were shaped by changes in domestic market structure and contracting practices induced by deregulation. The analysis concludes that deregulation played an essential role in each of the three major transformations in U.S. telecommunications equipment trade.

First, the time profile of the industry's bilateral trade imbalance closely tracks major changes in domestic market structure and contracting practices prompted by U.S. deregulation. Japanese deregulation occasionally reinforced these effects, while in other instances its effect on the bilateral trade imbalance was largely neutral. Second, the consequences of U.S. deregulation varied predictably within the industry according to the origin of entry barriers. Monopolies in "low-technology" terminal equipment, which had been sustained solely by regulatory barriers to entry, were quickly eroded by international factor cost differentials following early deregulation. By contrast, monopolies in "high-technology" network equipment, which were sustained additionally by economic barriers to entry, were eroded only by the combination of proactive deregulation and major technological advances. Finally, the initial uniqueness of the U.S.-Japan trade imbalance can be partially attributed to differences in the timing and scope of deregulation in the two countries. These differences impinged on both economic and regulatory barriers to entry.

The organization of the paper is as follows. Section 5.1 reviews the major transformations affecting U.S. telecommunications equipment trade during the

5. The political and economic forces leading to deregulation largely lie beyond the scope of this paper, which will concentrate on the effects of regulatory policy. Noll and Rosenbluth (1993) describe many of these forces as they relate to regulatory changes in the United States and Japan.

past decade and a half. Section 5.2 develops an empirical linkage between industry structure and foreign trade to explain patterns in "low-technology" terminal equipment trade. Section 5.3 undertakes a parallel analysis for "high-technology" network equipment. Finally, section 5.4 concludes by drawing implications for ongoing changes in the telecommunications equipment industry's structure.

5.1 Transformations in U.S. Telecommunications Equipment Trade

International trade in communications equipment has been a relatively recent phenomenon. Prior to the mid-1970s, equipment procurement historically had been confined within national borders in most industrialized countries, including the United States and Japan. Gradually, changes in technology and regulation opened national markets to foreign trade. This section documents three major transformations that shaped U.S. telecommunications equipment trade during the past fifteen years. First, the industry abruptly began a large and persistent trade deficit after 1982, distinguishing itself from trends in U.S. merchandise, durable goods, and advanced-technology trade. Second, the trade deficit's timing and persistence varied distinctly for low-technology terminal equipment versus high-technology network equipment. Third, these transformations initially were limited to U.S.-Japan trade, although subsequently they spread to U.S.-Asian and European-Japanese trade. These unique features of telecommunications trade led the United States to single out this industry for special bilateral negotiations, believing that Japanese trade practices and policies were primary contributors to the industry's difficulties.

5.1.1 Comparisons of Sectoral Trends

Having been a small net exporter of telecommunications equipment for almost a decade, after 1982, the United States abruptly began a persistent trade deficit. This reversal cannot be attributed simply to trends in U.S. overall merchandise trade or to trends for durable manufactures or advanced technology products in general. Figure 5.1 compares the trade balance for telecommunications equipment (scaled by industry shipments; series 1) with the total U.S. merchandise trade balance (scaled by GNP; series 2) for a twenty-five-year period.[6] Until 1982, the two series were strongly correlated. Industry and merchandise trade were approximately balanced until 1974, and even in later years, as telecommunications equipment moved into surplus while merchandise trade was in deficit, the two series rarely diverged by more than 3 percent. Since 1982, however, the two series have exhibited little correlation. After deregulation forced the breakup of AT&T, the U.S. trade balance in telecommunications equipment deteriorated at a rate nearly four times faster than the merchandise trade balance. In 1989, the telecommunications equipment deficit

6. Series numbers refer to data for figures appearing in app. A.

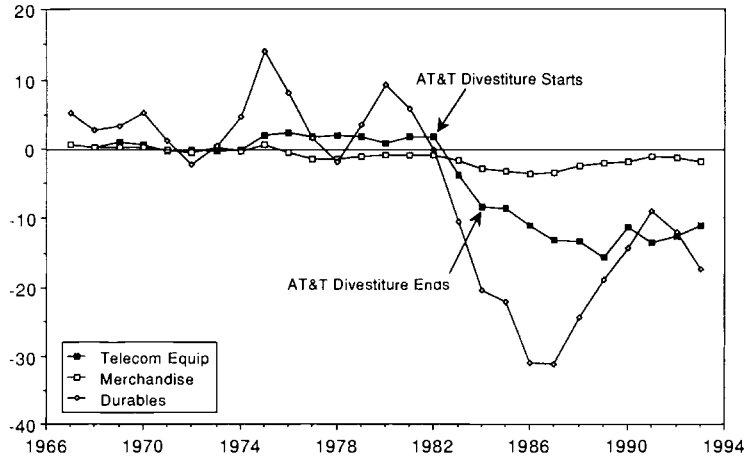

Fig. 5.1 Telecommunications equipment, merchandise, and durables trade balances (as a percentage of industry shipments or GNP)
Sources: U.S. Industrial Outlook (1970–74); *Statistical Abstract of the United States* (1971, 1981, 1994).

peaked at over 15 percent of industry shipments, while the merchandise trade deficit never reached 4 percent of GNP throughout the decade.

Narrowing the focus to durable manufactures confirms telecommunications equipment's unique recent history. The remaining series in figure 5.1 plots the U.S. trade balance for durable goods (scaled by sectoral shipments; series 3) over the same twenty-five-year period. Before 1982, the durable goods balance fluctuated widely in response to real exchange rate movements, while the telecommunications equipment balance remained essentially stable for fifteen years. This disparity was particularly evident between 1980 and 1982, when the (scaled) durable trade balance fell from 9.2 percent to −0.2 percent in response to a 32 percent real appreciation of the dollar, while the (scaled) telecommunications equipment trade balance actually rose modestly. After 1982, both trade balances deteriorated, but again their timing was not synchronized. As the dollar began its real depreciation in 1986, the durables trade deficit narrowed sharply, while the telecommunications equipment deficit merely stabilized.

Trade balance movements in telecommunications equipment also are distinguished from trends in other leading-edge industries. Figure 5.2 compares (unscaled) trade balances for telecommunications equipment and a basket of advanced-technology products between 1982 and 1993 (series 4 and 5).[7] Tele-

7. Since 1982, the Department of Commerce has tracked trade balances for a basket of products that employ leading-edge technologies. The basket covers the following sectors: advanced materials, aerospace, biotechnology, electronics, flexible manufacturing, information and communications, life sciences, nuclear technology, optoelectronics, and weapons.

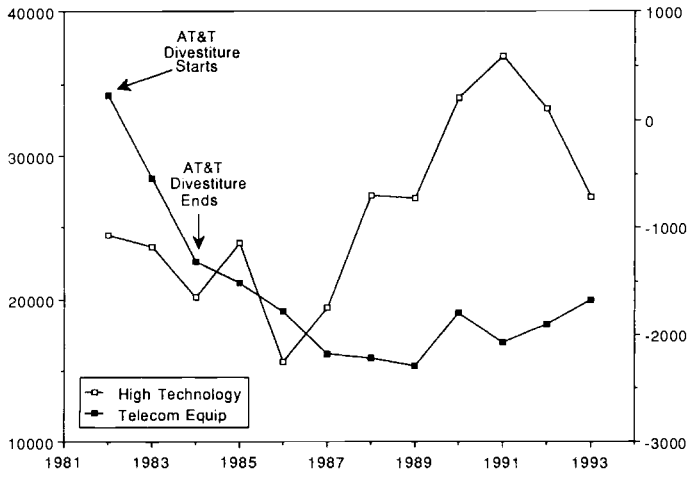

Fig. 5.2 Telecommunications equipment and high-technology trade balances (in millions of current dollars). Left axis: high-technology products; right axis: telecommunications equipment.

Sources: U.S. General Accounting Office (1992); *U.S. Industrial Outlook* (1982–94); *Statistical Abstract of the United States* (1994).

communications equipment is distinguished by both the level and the direction of change in its trade balance. While the United States maintained a surplus in advanced technology products throughout the decade, telecommunications equipment was consistently in deficit after 1982. The advanced-technology trade surplus also grew slightly over the decade (in nominal terms), while the telecommunications equipment trade deficit instead widened sharply.

5.1.2 Comparisons of Intraindustry Trends

While telecommunications equipment distinguished itself from aggregate and sectoral trade trends, it also exhibited substantial intraindustry variation in the timing and persistence of trade deficits. Telecommunications systems consist of three interconnected components: terminals, transmission lines, and switches. Terminals are used to send and receive voice and data communications. *Terminal equipment* includes handsets, modems, facsimile machines, and simple key telephone sets that allow access to multiple lines and services such as call forwarding and conferencing. *Network equipment* collectively refers to switches and transmission lines. Switches act like the central nervous system of the network by controlling call routing across telephone exchanges and service carriers.[8] Switches may be located either in a telephone company's premises (central office switches, or COSs) or in a customer's facilities (private branch exchanges, or PBXs). Transmission lines complete the network system

8. Switches also perform complementary functions such as tracking calls for billing purposes.

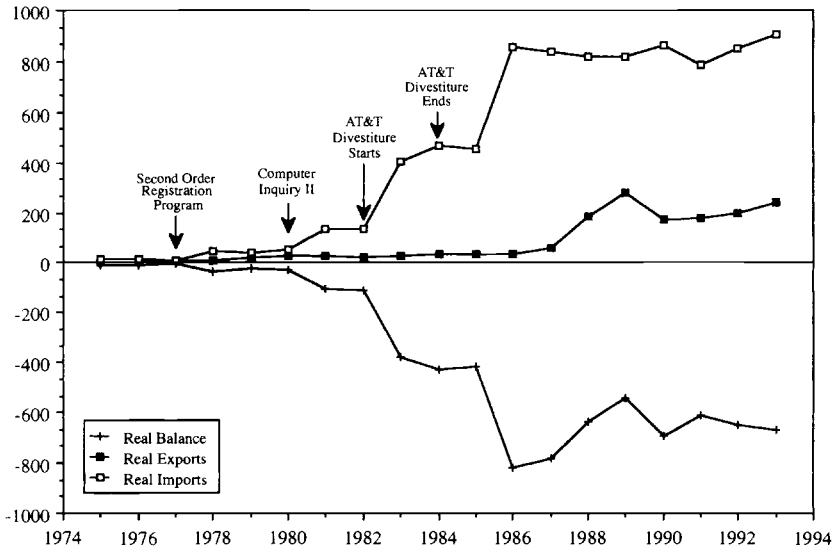

Fig. 5.3 U.S. trade in terminal equipment (in millions of 1982 dollars)
Source: Electronic Market Data Book (1975–94).

by connecting individual switches. Transmission can occur either along wires and optical fibers (wireline communication) or over the electromagnetic spectrum by microwave, radio, and satellites (wireless communication).

The United States has run a persistent trade deficit in terminal equipment since the effective inception of international telecommunications trade in 1975, as summarized in figure 5.3 (series 6–8). The sharpest deterioration in this trade balance occurred between 1980 and 1986, when the terminal equipment deficit ballooned in real terms from $30 to $820 million before narrowing slightly in later years. These movements were driven overwhelmingly by imports, which grew from less than $50 million during the late 1970s to exceed $850 million by 1986. As a share of domestic consumption, imports rose from less than 2 percent during the mid-1970s to 11.2 percent by 1981 and to 55.3 percent by 1986 (series 9). Through this period, Japan supplied between 37 and 43 percent of terminal equipment imports, making it the largest foreign supplier to the U.S. market (U.S. International Trade Commission 1984, table H-14). After 1985, Taiwan, Hong Kong, and South Korea displaced Japan to become major suppliers to the United States of generic telephone equipment. In contrast to import trends, U.S. terminal equipment exports remained stable and below $60 million until the late 1980s, when development of specialty, software-intensive equipment and deregulation of European telecommunications markets allowed U.S. exports to grow gradually to $200–$250 million.

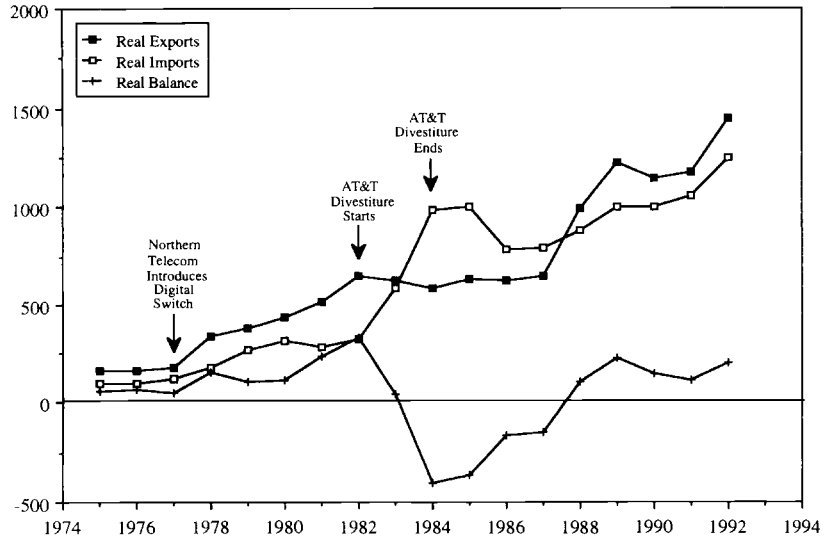

Fig. 5.4 U.S. trade in network equipment (in millions of 1982 dollars)
Source: Electronic Market Data Book (1975–94).

After 1990, U.S. imports of (generic) terminal equipment outstripped exports of (specialty) terminal equipment by a four-to-one ratio.

Network equipment, by contrast, maintained a relatively small trade surplus through 1982, as summarized in figure 5.4 (series 10–12). Between 1982 and 1984, however, the United States abruptly became a substantial net importer as real imports more than tripled from $319 to $983 million and imports doubled as a share of network equipment purchases to reach 16.3 percent (series 13). Since 1984, growth in imports and import penetration has been more modest, reflecting a solidification of network equipment supply relations. Canada's Northern Telecom has remained the largest supplier of U.S. network equipment imports (with a 57.9 percent share in 1989), reflecting the early foothold that the firm achieved after introducing digital technology switches in 1977. The remainder of the U.S. import market has been divided almost evenly between Japan's NEC, Fujitsu, Toshiba, and Hitachi (with a combined share of 18.8 percent) and Europe's Siemens and Ericsson (with a combined share of 15.5 percent).[9] Throughout this period, U.S. real exports of network equipment remained relatively stable and did not begin growing until after 1987, in response to European telecommunications deregulation. This delayed export growth, reinforced by dampened import growth after 1984, helped return the

9. My calculations, based on data in Vietor and Yoffie (1993, 162). Shares sum to less than 100 percent because the country of origin of some imports could not be determined.

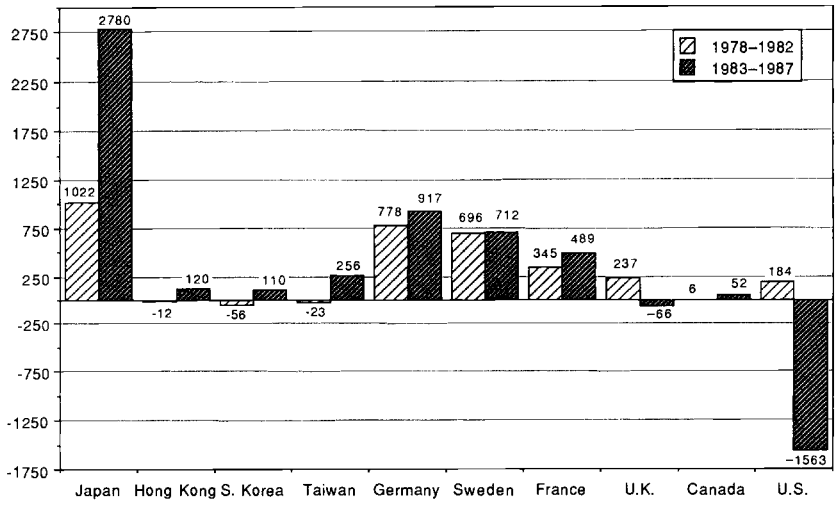

Fig. 5.5 Average trade balances for major telecommunications equipment producers (in millions of current dollars)
Source: Organization for Economic Cooperation and Development (1991).

United States to a small trade surplus in network equipment beginning in 1988, although it continued to be a large net importer from Japan.

5.1.3 Comparisons of Regional Trends

The perception of the telecommunications equipment trade imbalance as a "U.S.-Japan problem" can be attributed to the industry's third transformation. In the early 1980s, the United States was virtually the only major producer of telecommunications equipment to become an overall net importer—a shift that was precipitated largely by its trade relations with Japan. Only later did patterns in U.S.-Japan trade spread to U.S.-Asian and Japanese-European trade.

Figure 5.5 compares trade balances among ten major telecommunications equipment producers between 1978 and 1987. The countries divide themselves naturally into three groups. The first group consists of the United States and Japan, which experienced the largest changes in their industry trade balances. During this decade, the United States moved from a surplus of $184 million to a deficit exceeding $1.5 billion, while Japan's trade surplus grew from $1.0 to $2.8 billion. The second group includes smaller Asian producers (Hong Kong, South Korea, and Taiwan), which became net exporters by supplying generic terminal equipment to the United States in large volume after the mid-1980s. The final group consists of European producers and Canada, which maintained comparatively stable trade balances over the decade. An exception was the United Kingdom, which began telecommunications deregulation in 1984 and, like the United States, became a net importer of equipment.

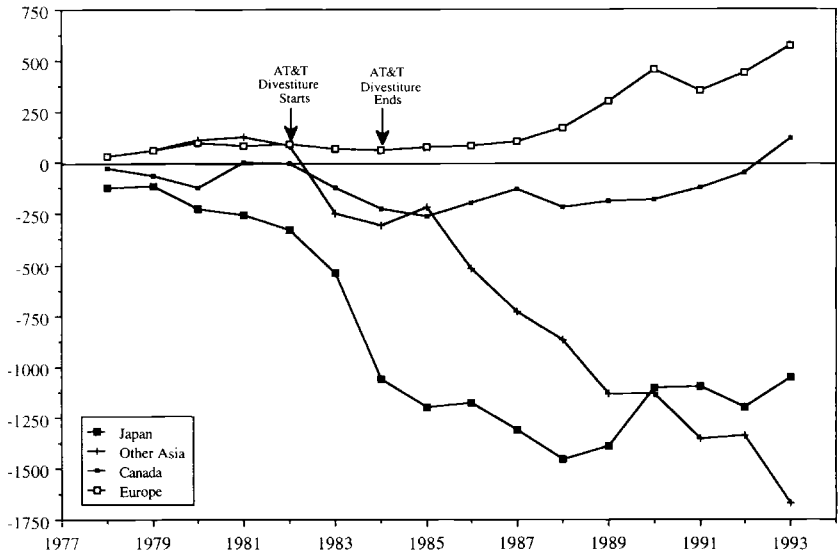

Fig. 5.6 U.S. telecommunications equipment regional trade balances (in millions of 1982 dollars)
Source: U.S. Industrial Outlook (1978–94).
Note: "Other Asia" consists of Hong Kong, South Korea, and Taiwan.

By disaggregating trade balances regionally, figure 5.6 (series 14–25) confirms the initial uniqueness of the U.S.-Japan imbalance. Through 1990, the largest U.S. regional trade deficit was with Japan. Between 1982 and 1989, Japanese imports grew from $356 to $1.62 billion, while U.S. exports to Japan rose from just $25.0 to $236.4 million. The eventual narrowing of the U.S.-Japan trade deficit stemmed not from subsequent growth in U.S. exports but instead from the substitution of terminal equipment imports from smaller Asian producers—principally Hong Kong, South Korea, and Taiwan. Import *growth rates* from these three sources had actually matched or exceeded Japanese import growth since 1984, but import *levels* remained constrained by the residential effects of industrialized countries' regulatory barriers that had confined equipment producers to their normal markets. U.S.-Japan trade also distinguished itself from the relative stability of the U.S. regional trade balance with Europe and Canada. Historically, the United States maintained a moderate trade surplus with Europe, which widened in the late 1980s, following the deregulation of major European telecommunications markets. The United States historically maintained a moderate deficit with Canada, which widened after 1982, following the deregulation of the United States market.[10]

10. Trade with both of these regions has been concentrated overwhelmingly in network equipment.

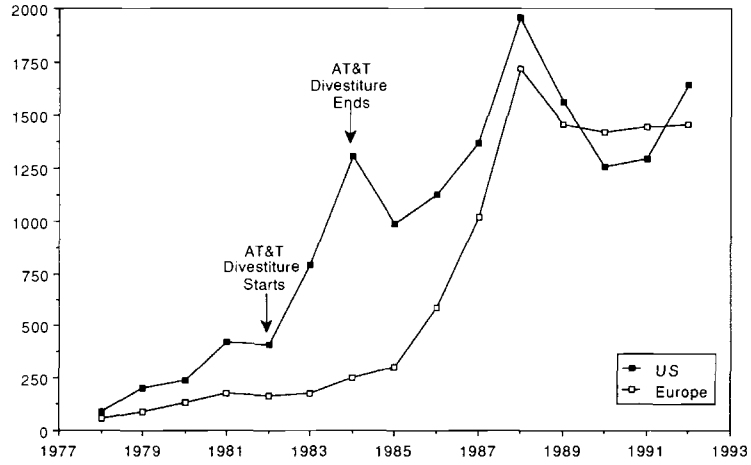

Fig. 5.7 Japanese telecommunications equipment regional trade balances (in millions of 1982 dollars)
Source: Japan Electronics Almanac (1981–84).

The initial uniqueness of the U.S.-Japan imbalance is reinforced by comparing it to Japan's trade with Europe in this industry, as summarized in figure 5.7 (series 26 and 27).[11] Prior to the mid-1980s, Japan's widening industry surplus was driven almost entirely by trade with the United States. The sharpest early growth in Japan's surplus also coincided with final deregulation of the U.S. telecommunications market between 1982 and 1984. Through 1985, by comparison, Japan maintained only a small trade surplus with Europe. Later, as Europe gradually began deregulating telecommunications, Japanese-European trade began to follow Japanese-U.S. patterns, with a four-year delay. By the early 1990s, the United States and Europe were experiencing comparably sized trade industry deficits with Japan.

5.1.4 Criteria for Explaining Trade Patterns

The distinct characteristics of telecommunications equipment trade patterns, summarized in figures 5.1–5.7, establish three criteria for a theory to explain the industry's trade dynamics. First, the fact that telecommunications equipment trade patterns diverged abruptly from general merchandise, durable goods, and advanced-technology trends after 1982 necessitates an explanation that is industry specific. Second, variation in the timing and persistence of the deficit across equipment categories implies that the explanation should take account of intraindustry differences in demand and technology features. Fi-

11. U.S. and Japanese industry classifications differ slightly, leading to discrepancies between the series depicted in figs. 5.6 and 5.7. Comparable data for Japan-Canada and Japan-Asia telecommunications equipment trade were unavailable.

nally, the fact that these trends initially were peculiar to U.S. trade with Japan implies that an explanation should emphasize interactions between these countries. At the same time, because these trends eventually spread to U.S.-Asian and Japanese-European trade, a complete explanation should also include reference to those countries' telecommunications markets and institutions. Sections 5.2 and 5.3 adopt these criteria to explain the origins and evolution of the U.S. telecommunications equipment industry's trade imbalance.

5.2 Trade Conflicts in Terminal Equipment

This section assesses how domestic market structure and procurement practices in the United States and Japan shaped bilateral trade in terminal equipment. Terminal equipment consists primarily of low-technology, labor-intensive products, including telephone handsets, answering machines, and modems. Economic barriers to entering terminal equipment production are minimal, as a result of rapid technology diffusion, minimal scale economies, and weak demand complementarities. However, through the late 1970s, regulatory barriers effectively excluded all but a few domestic suppliers in both U.S. and Japanese markets. The result was that terminal equipment imports remained below 2 percent of equipment purchases in both countries, despite the fact that U.S. labor costs were twelve times and Japanese labor costs six times higher than wages prevailing in Hong Kong, South Korea, and Taiwan.

U.S. deregulation lowered entry barriers in stages between 1977 and 1984 and was followed by a series of sharp jumps in terminal equipment import penetration, which eventually rose to exceed 85 percent. Japan initially accounted for the largest share of these imports, reflecting its head start in installed capacity that had been exclusively supplying the world's second largest captive telecommunications market. The conclusion of U.S. deregulation in 1984, coupled with a sharp rise in Japanese labor costs between 1985 and 1988, enabled Hong Kong, South Korea, and Taiwan to begin large-scale production of terminal equipment and eventually to displace Japan as leading exporters to the United States. Deregulation of the Japanese market after 1981, by comparison, had relatively little effect on the bilateral imbalance in terminal equipment. While Japanese imports from lower-cost Asian sources rose sharply, high U.S. labor costs continued to limit U.S. exports to a small range of specialty, software-intensive terminal equipment.

5.2.1 Economic Barriers to Entry

The economics of terminal equipment manufacturing traditionally did not erect perceptible barriers to entry. To begin, economies of scale were exhausted at very low rates of production. Huber (1987, 17-7) found that U.S. firms reached minimum efficient scale with as little as 3 percent market share, and Brock (1981, 235) confirmed that scale economies for terminal equipment were comparable to those for any other small electrical appliances. Production

cost penalties therefore were unlikely to deter potential entrants from entering at a small scale.

Lack of access to manufacturing technologies also did not erect an economic barrier to entry in this industry. Technology for terminal equipment had grown increasingly standardized as a result of two forces. The first was the traditional routinization and labor intensification of manufacturing methods as the product cycle progressed, described by Vernon (1966).[12] The second was technology dissemination among firms that was hastened by AT&T's court-imposed obligation in 1956 to license its patents to all applicants at a "reasonable royalty." AT&T licenses proved to be particularly important to the development of Japan's telecommunications industry (Baughcum 1986, 83).

Finally, terminal equipment's inherent simplicity lessened possible barriers to entry from the demand side. Because terminal equipment required little customization or after-sale service, there was no economic necessity for the location of consumption to be tied geographically to the location of production. The position of terminal equipment as the final node in the telecommunications system would also facilitate entry. Each terminal instrument was linked to a network switch, rather than directly to other terminal equipment, thereby removing any technical necessity to assure complete uniformity among individual products.

The absence of economic barriers to entry has direct implications for industry structure, contracting practices, and foreign trade in terminal equipment. First, the U.S. market should have been able to support a large number of competitive suppliers. In practice, however, one firm—Western Electric—supplied over 85 percent of domestic terminal equipment demand. Second, nondiscriminatory contracting should have been economically viable. In practice, however, terminal equipment was sold through exclusive contracts based on long-term supply relations. Finally, in an industry where economic barriers to entry were minimal, production locales should have been determined by relative factor costs. In 1975, average hourly compensation for manufacturing production employees was $6.36 in the United States, which compared with $3.05 in Japan and between $0.34 and $0.76 among smaller Asian producers (fig. 5.8, series 28–32).[13] Despite these substantial labor cost differentials, however, imported terminal equipment accounted for less than 2 percent of the U.S. (and Japanese) markets through the mid-1970s. In the absence of economic entry barriers, an explanation lies elsewhere for the U.S. terminal equipment indus-

12. As for many electronics products, the product life cycle for most telecommunications equipment involves a race to innovate leading-edge products followed by a race to routinize manufacturing processes to transform a proprietary device into a standardized commodity.

13. While time-series data on international labor costs are available only for a manufacturing composite, for at least one year these data are closely correlated in the cross section with compensation costs for electric and electronic equipment manufacturing. In 1983, average hourly compensation for this sector was $11.90 in the United States (compared with $12.10 for all manufacturing), $5.54 in Japan ($6.13), $1.29 in Korea ($1.20), and $1.31 in Taiwan ($1.27) (International Trade Administration 1986, 79).

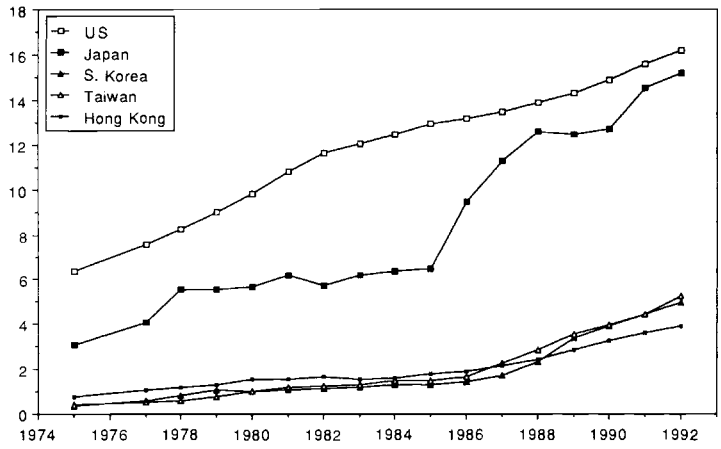

Fig. 5.8 Compensation costs for production workers in manufacturing industries (in current dollars per hour)

Source: International Comparisons of Hourly Compensation Costs for Production Workers in Manufacturing (1988, 1993).

Note: Compensation includes pay for time worked, other direct pay, social insurance, and private benefits.

try's extraordinarily high seller concentration, its reliance on exclusive supply contracts, and the apparent interdependence between supply and relative costs.

5.2.2 Regulatory Barriers to Entry in the United States

Until its divestiture on 1 January 1984, AT&T was both the largest manufacturer and the largest purchaser of telecommunications equipment in the United States. As the parent company for the Bell Telephone system, AT&T supplied all long-distance service through its Long Lines Department, while its twenty-four regional Bell operating companies (BOCs) supplied local service for 85 percent of the U.S. market.[14] AT&T's manufacturing subsidiary, Western Electric, supplied nearly all the entire Bell system's equipment requirements. Equipment was supplied under exclusive contracts, which established a multi-billion-dollar captive market for Western Electric. AT&T also owned the Bell Laboratories, which worked closely with the BOCs and Western Electric to develop and commercialize new equipment. This monopolistic market structure, which had evolved over decades of industry consolidation, was officially sanctioned by the Department of Justice in a 1956 consent decree that settled an antitrust complaint against AT&T.[15]

14. The remainder of the local market was served by a large number of independent telephone companies, of which GTE was the largest.

15. The antitrust complaint charged AT&T with a conspiracy to restrain trade in telephone service and charged AT&T's equipment subsidiary, Western Electric, with monopolizing the market for telephones and related equipment. The consent decree contained three central provisions:

Telecommunications was regulated at both the federal and state levels. The Federal Communications Commission (FCC) had jurisdiction for approving charges for interstate and international service, while states' public utility commissions (PUCs) set intrastate charges. Both agencies used traditional rate of return regulation, which set a maximum allowable profit rate for AT&T on telephone calls and equipment sales. Regulators also authorized the terms under which telephone service would be provided. Competitive entry was directly controlled by a regulatory mandate that "[n]o equipment, apparatus, circuit or device not furnished by the telephone company shall be attached to or connected with the facilities furnished by the telephone company" (Brock 1981, 239). The effect of this mandate was to prevent customers from legally purchasing a telephone from an independent company and then attaching it to AT&T's telecommunications network. While some unauthorized attachments did occur, AT&T aggressively monitored the number of telephones attached to each line, and the company penalized violators by seizing independent equipment or denying telephone service.

Entry was indirectly controlled further by regulations requiring subscribers to lease their terminal equipment from their local BOC, which in turn purchased the equipment exclusively from Western Electric. By tying telephone equipment to service, AT&T forced potential equipment suppliers to establish their own local telephone company to service their customers. State regulators generally declined to license new competitors in local telephone markets, and substantial economic barriers to entry existed in providing telephone service owing to large network economies. The result was that entry into telephone service was a roundabout and usually unprofitable route for entry into terminal equipment manufacturing. AT&T's tie-in strategy and exclusive supply arrangement with the BOCs therefore left little scope for competition in terminal equipment, from either domestic or foreign sources.

It is critical to underscore that telecommunications regulation provided AT&T with both the incentive to exclude competitors and the means to control equipment distribution. In the absence of a regulatory cap on its profit rate, AT&T could have charged (near) monopoly prices for telephone service. In an unregulated market, therefore, neither a tying arrangement nor exclusive contracting would have extended AT&T's market power from telephone service to the terminal equipment market because the monopoly profit could have been collected only once. Nor would an unregulated monopolist have chosen to manufacture terminal equipment unless it were the minimum-cost producer since a mandated purchase and leasing scheme would only have reduced the maximum profit that AT&T could extract from its (near) monopoly in tele-

First, as noted earlier, AT&T was required to license its patents on reasonable and nondiscriminatory terms. Second, AT&T was required to confine its activities to regulated common carrier service in the domestic market. Finally, Western Electric was permitted to manufacture equipment only for use within the Bell system.

phone service. In this situation, therefore, AT&T would have had no incentive to insist on leasing equipment to subscribers or to insist that its regional operating companies purchase their equipment under exclusive arrangements, unless these could be justified for purely cost-saving reasons.

But, under federal and state regulation, AT&T's allowable profit was constrained by the size of its rate base. Profits therefore depended on the firm's costs, and higher costs implied larger revenues and greater allowable profits, provided that demand was inelastic. A regulated AT&T therefore would profit by extending its (constrained) monopoly power from telephone service into the terminal equipment market by using sales under the tie-in and exclusive supply contract to expand its rate base. Regulation thus enabled a telephone company that controlled terminal equipment to earn profits on its sale *twice:* once at the manufacturing stage, by charging its subsidiaries inflated prices, and then again as profit on the rate base for the local telephone company, which leased the equipment to subscribers. If the BOCs had been allowed to purchase equipment from competitive sources, in lieu of the exclusive supply contracts, AT&T's downstream source of profit would have been eliminated by shrinkage of its rate base. And, if telephone subscribers had been permitted to purchase terminal equipment from competitive sources in lieu of the tie-in, both sources of AT&T profit would have been eliminated by shrinking the rate bases of both AT&T and the BOCs.[16]

Facing these regulatory incentives, AT&T vigorously protected its (near) monopoly by consistently opposing entrants' attempts to liberalize regulations governing independent equipment attachments. The first attempt to challenge AT&T's control over attachments to the network came in 1956 with the Hush-a-Phone case. The Hush-a-Phone was a simple cuplike device that snapped onto the end of a telephone to provide speaking privacy and shield out surrounding noises. The manufacturer of Hush-a-Phone petitioned the FCC to allow the attachment to be sold directly to telephone subscribers. AT&T vigorously opposed the petition, asserting that the device threatened network service quality. After protracted legal battles, the FCC eventually sided with Hush-a-Phone but tailored its ruling narrowly to carve out an exception solely for this device. The potential effect of the FCC ruling was dampened further when its implementation was left to local telephone companies, which engaged in delaying tactics for more than two decades before terminal equipment markets finally were opened to competition.

16. AT&T's tying of telephone equipment to service also facilitated nonlinear price discrimination that would not have been feasible in the absence of regulation. Subscribers that attach a higher valuation to service tend to demand more telephones per line. To charge a higher effective price per call to those subscribers, nonlinear price discrimination would combine a relatively low rate for telephone service with a relatively high leasing fee for terminal equipment. Because this metered pricing scheme placed the largest price-cost markup on the product for which entry was easiest (terminal equipment), however, a formal tying arrangement was necessary to support price discrimination. Regulatory barriers to entry in local telephone service markets provided the means for enforcing this tie-in and further raised AT&T's profits.

AT&T repelled a second entry challenge in 1986. The Carterphone was a relatively simple attachment that converted telephone signals into radio signals for broadcast to a mobile radio/telephone. AT&T opposed the Carter Electric Company's attempt to sell the attachment directly to final users. The FCC eventually ruled in Carter's favor but allowed AT&T to require purchasers of the Carterphone to lease a telephone-company-supplied coupling device for the asserted purpose of protecting the network from harm. In some cases, the charge for the protective device was as high as the monthly charge for basic telephone service (Brock 1981, 242). This discriminatory fee was structured to make it uneconomical for Carter to sell its attachment except to subscribers with very large telephone systems. The result was that FCC policy continued to maintain entry barriers in most of the U.S. terminal equipment market.

5.2.3 Deregulation of the U.S. Market

Under increasing domestic political pressure, the FCC began a gradual process of opening terminal equipment markets to competition, starting in the mid-1970s.[17] An initial opportunity to lower regulatory barriers to entry came in October 1975 with the FCC's first order registration program. The program sought to provide non-Bell equipment manufacturers with controlled access to AT&T's subscriber network. The FCC proposed to test independents' equipment, certify products that posed "no harm" to network quality, and permit those products to be attached legally to telephone lines by subscribers. In practice, however, the program did little to facilitate entry. Its narrow scope excluded the majority of terminal equipment (telephones, key sets, and PBXs), and AT&T and its subsidiary BOCs succeeded in delaying implementation of the modest deregulation order for two years.

The first meaningful deregulation of the U.S. terminal equipment market occurred in October 1977 with the adoption of the second order registration program. The program permitted telephone subscribers to attach directly most types of non–Western Electric terminal equipment (including telephones, key sets, and PBXs) to the AT&T network. Competitive entry quickly followed this partial lowering of regulatory entry barriers, confirming that, in the absence of economic barriers, supply would be determined by relative factor costs. Between 1977 and 1978, real imports of terminal equipment jumped 30 percent (from $11.2 to $44.1 million), and import penetration rose from 1.4 to 4.5 percent. During this period, Japan supplied approximately 45 percent of U.S. terminal equipment imports, amounting to just over 2 percent of total U.S. purchases (U.S. International Trade Commission 1984, table H-14). While imports grew rapidly, market access remained limited by an FCC requirement that subscribers notify their local telephone company when they attached non–Western Electric equipment. As with the earlier entry threat from Carterphone,

17. Appendix B provides a time line of major regulatory changes.

AT&T used this regulatory loophole to monitor attachments and to charge a discriminatory fee to subscribers using independent equipment. Surveillance proved to be very costly, however, and compliance rates with the FCC requirement were estimated at only 20 percent, indicating that the second order registration program did in fact begin to lower regulatory entry barriers (Brock 1981, 251).

Entry barriers were lowered again in 1980 when the FCC removed terminal equipment from rate-of-return regulation and required AT&T to sell terminal equipment to telephone subscribers directly rather than indirectly leasing equipment through the BOCs.[18] The immediate effect of the FCC order was to remove terminal equipment from AT&T's and the BOCs' rate bases. Because rate-of-return regulation had been the sole rationale for AT&T's exclusionary practice of tying telephone equipment and service, deregulation therefore eliminated AT&T's incentive to monopolize the local terminal equipment market. The result was a second surge in U.S. terminal equipment imports. Between 1980 and 1981, real imports of terminal equipment rose from $56.2 to $132.5 million, and imports increased as a share of domestic consumption from 5.9 to 11.2 percent in the same year (fig. 5.3 above, series 8 and 9). Japan's import share rose to 54 percent during this period, and its share of the U.S. market increased to just over 6 percent (U.S. International Trade Commission 1984, table H-14).

The final—and furthest-reaching—deregulation order was issued in August 1982, with the announcement of the Modification of Final Judgment (MFJ) as an out-of-court settlement to a 1974 antitrust suit against AT&T.[19] Under the terms of the MFJ, AT&T agreed to fully divest itself from the local BOCs by 1 January 1984. The centerpiece of the divestiture order was the severing of exclusive equipment supply contracts that had prevailed for five decades between AT&T and the BOCs. After 1982, the local telephone companies—which the MFJ now grouped into seven regional holding companies (RHCs)—were permitted to purchase terminal equipment directly from independent manufacturers. Henceforth, all equipment contracts involving AT&T were required to be negotiated on arm's-length, nonpreferential terms. The MFJ also prohibited the RHCs from vertically integrating upstream to supply their internal demand for telephone equipment. By divorcing the local carriers from their former parent company, requiring competitive contracting, and precluding self-supply, the MFJ removed the last remaining regulatory barriers to entry in the U.S. terminal equipment market.[20]

The conclusion of deregulation precipitated another surge in terminal equipment imports. Between 1982 and 1984, real imports jumped from $136.0 to

18. The order resulted from the FCC's Computer II Inquiry.

19. The agreement is known as the Modification of Final Judgment because it modified the terms of the original consent decree that the industry had operated under since 1956.

20. Under the MFJ's terms, AT&T was allowed to continue producing its own equipment for long-distance service. Western Electric was renamed AT&T Technologies after 1982.

$466.7 million, and import penetration tripled from 11.6 to 37.5 percent (fig. 5.3 above, series 8 and 9). During this period, Japan remained the largest foreign supplier of terminal equipment in the United States with a 14 percent share of all purchases, reflecting its 50 percent manufacturing labor cost advantage. However, Japan's share of U.S. imports also started to decline, falling from 54 percent in 1981 to 46 percent in 1982 and then 37 percent in 1983 as smaller, lower-cost Asian producers began large-scale manufacturing of terminal equipment (U.S. International Trade Commission 1984, table H-14).

Telecommunications regulation in the United States and most other industrialized countries had historically constrained terminal equipment manufacturers worldwide to supply only their local market. For Hong Kong, South Korea, and Taiwan, which had small domestic telecommunications markets, foreign regulatory barriers precluded expansion of capacity to exploit their considerable manufacturing labor cost advantage (fig. 5.8 above, series 28 and 30–31). Final deregulation of the U.S. terminal equipment market in 1982, however, opened a potential marketplace of 93 million telephone lines (Organization for Economic Cooperation and Development 1991, table 1). This market opportunity prompted large-scale investments in telecommunications equipment manufacturing in Hong Kong, South Korea and Taiwan, which permitted rapid growth in export sales to the U.S. market. In 1979, the three countries accounted for just 8.5 percent of U.S. imports of terminal equipment (and 0.3 percent of U.S. consumption). By 1982, their import share had risen to 28.4 percent (3.3 percent of U.S. consumption), and, by 1983, it had reached 45.3 percent (15.4 percent of U.S. consumption) (U.S. International Trade Commission 1984, table H-14).[21]

Between 1985 and 1988, Japanese manufacturing labor costs jumped 82 percent, bringing them to within 91 percent of U.S. rates (fig. 5.8 above, series 28 and 29). In response, terminal equipment production continued to shift toward Hong Kong, South Korea, and Taiwan, which maintained between a seven-to-one and ten-to-one labor cost advantage. After 1985, U.S. imports from the rest of Asia grew nine times as rapidly as imports from Japan (series 16 and 22). The import surge after 1985 was short-lived, however, as real U.S. terminal equipment demand peaked in 1986. Beginning in 1987, real consumption began falling in response to saturation of the U.S. market after five years of imports of generic terminal equipment from Asia. Thus, while real import growth slowed appreciably after 1986, when combined with an average 8.2 percent annual decline in real consumption between 1986 and 1992, import penetration rates continued rising and eventually exceeded 90 percent in this market (series 9).[22]

21. Individual country import shares in 1979 (and 1983) were as follows: Hong Kong, 1.8 percent (14.8 percent); South Korea, 3.4 percent (10.3 percent); and Taiwan, 3.2 percent (20.2 percent).

22. Real consumption of terminal equipment fell from $1.54 billion in 1986 to $961 million in 1992. Import penetration during this period grew from 55.3 to 88.1 percent (*Electronic Market Data Book* 1994).

5.2.4 Regulation and Deregulation in Japan

Japan's telecommunications equipment market closely resembled its American counterpart, the result of common economic fundamentals and very similar regulatory structures. In 1952, Nippon Telegraph and Telephone (NTT) was established as a publicly owned monopoly supplier of telephone service. Regulations by Japan's Ministry of Posts and Telecommunications (MPT) required telephone subscribers to lease their terminal equipment directly from NTT, which purchased equipment under a preferential agreement from a small family of suppliers headed by the Nippon Electronic Corporation (NEC).[23] NTT was given exclusive authority by the MPT to approve communications equipment for attachment to its network. NTT established technical specifications for equipment that were based on specific design criteria rather than general performance standards and wrote these specifications to favor NEC family members. NTT's certification procedures were complex and time consuming, and independent equipment manufacturers frequently faced difficulties in convincing NTT to divulge even what the technical criteria were. Further, for more sophisticated terminal equipment such as key telephones, separate approval was required for each individual installation.

These regulatory barriers and preferential contracting practices (supported by regulatory authority) effectively curtailed entry into terminal equipment manufacturing. Few Japanese manufacturers that were not associated with the NEC family supplied equipment to NTT. Japanese imports of terminal equipment from the United States totaled just $121,000 in 1978 (U.S. Congress 1980, 27). The strongest evidence of regulatory barriers, however, is found in the fact that Japan's overall import penetration ratio for terminal equipment was only 1.2 percent in 1978, despite Japan's six-to-one manufacturing labor cost disadvantage relative to small producers in Hong Kong, South Korea, and Taiwan (fig. 5.8 above, series 29–32) (*Japan Electronics Almanac* 1984, table 7).

Deregulation of Japanese telecommunications commenced four years after initial liberalization in the United States. In January 1981, the Japanese market was partially deregulated to permit telephone subscribers to purchase some terminal equipment directly from independent manufacturers. However, NTT retained its monopoly for supplying the first telephone in a subscriber's premises and retained its authority to inspect and certify independent equipment for compliance with technical standards before it could be connected to the network. Shortly thereafter, however, certification procedures were significantly liberalized by NTT's decision to accept test data from independent manufacturers to expedite certification of their products.[24] After 1981, NTT approved most

23. The NEC family included NEC, Fujitsu, Hitachi, and Oki. An exception to the mandatory equipment leases applied to large PBXs, where NTT allowed direct dealings between equipment suppliers and telephone subscribers.

24. NTT's revised procedures were pursuant to the Understanding on the Interconnect Market negotiated with the United States in 1981.

requests for attachments of independent terminal equipment (U.S. General Accounting Office 1983, 15). Despite deregulation, however, the U.S. share of the Japanese market rose just marginally to 1.1 percent (*Japan Electronics Almanac* 1984, table 7; U.S. International Trade Commission 1984, table H-14; *U.S. Industrial Outlook* 1984). While U.S. export continued to face some regulatory barriers to entering the Japanese market, the primary obstacle remained high U.S. manufacturing labor costs. For this reason, exports of terminal equipment to Japan were limited to software-intensive devices such as video conferencing and voice processing that required skilled assembly.

Deregulation of Japan's terminal equipment market was completed in April 1985, amid trade frictions with the United States and pressure from large Japanese telecommunications users seeking lower charges. The NTT Company Law and the Telecommunications Business Law were enacted to institute three regulatory reforms. First, NTT's monopoly over subscribers' first telephone was rescinded. Second, authority for equipment approval was removed from NTT and placed in an independent standards board, the Japan Approval Institute for Telecommunications, which instituted simplified and transparent certification procedures (Choy 1995). Finally, NTT was converted into a semiprivate corporation subject to competition from independent telephone service providers that were not tied to the NEC equipment family.

Despite apparent compliance by NTT with each reform, removal of these final regulatory barriers again had little effect on U.S. terminal equipment exports to Japan.[25] That the United States was at a 50 percent manufacturing labor cost disadvantage remained the central impediment limiting its exports to just 10 percent of Japan's total purchases of foreign terminal equipment. While U.S. exports rose by 30 percent after Japanese deregulation, they remained less than $5 million in total. By contrast, Japanese deregulation spurred rapid growth in terminal equipment production among smaller Asian countries, where manufacturing labor costs were one-quarter to one-seventh. After 1985, Japanese imports of terminal equipment from South Korea, Hong Kong, and Taiwan increased 160 percent annually. Asian imports accounted for 88 percent of total Japanese purchases of foreign terminal equipment and in absolute level were nine times greater than U.S. imports (*Japan Electronics Almanac* 1989, 165–67).

5.2.5 Summary

Regulatory policy played a dominant role in shaping terminal equipment markets in the United States and Japan. Despite minimal economic barriers to entry, regulatory barriers created and protected local monopolies that suppressed competitive entry. The result was that, through the mid-1970s, imports constituted less than 2 percent of U.S. and Japanese terminal equipment pur-

25. U.S. telecommunications companies generally attested to Japanese compliance with the 1985 reforms (U.S. General Accounting Office 1988, 22–23).

chases, despite substantial manufacturing labor cost disadvantages in both countries relative to low-age Asian sources. Deregulation occurred first in the United States, starting in 1977 and culminating in the 1982–84 dissolution of the Bell system. Deregulation followed in Japan between 1981 and 1985. In both countries, imports from comparatively lower-cost sources grew rapidly following deregulation. Japan benefited from U.S. deregulation and gained a substantial market share, only to be supplanted in the second half of the 1980s by still lower-cost Asian suppliers. In contrast, after Japanese deregulation, high factor costs continued to limit U.S. terminal equipment exports to a small range of complex, specialty products. The combined effect of deregulation in the U.S. and Japanese markets, therefore, was to create a substantial U.S. trade deficit immediately following the opening of those markets to competition.

5.3 Trade Conflicts in Network Equipment

This section assesses how domestic market structure and procurement practices in the United States and Japan shaped bilateral trade in network equipment. In both countries, trade historically had been limited by the presence of domestic monopoly suppliers with preferential ties to local service providers. This market structure was favored by the coexistence of substantial scale economies in production and network economies in demand. These economic entry barriers were reinforced by regulatory policies that favored exclusive supply relations and set design standards to exclude competitors. Economic and regulatory barriers together limited network equipment imports to less than 5 percent of the U.S. market and less than 1 percent of the Japanese market through the late 1970s (*Electronic Market Data Book* 1979; *Japan Electronics Almanac* 1984, table 7).

Entry barriers into the U.S. network equipment market were lowered by two complementary events. Together, they created a window of market contestability. The first event was the introduction of digital switches in 1977 by Canada's Northern Telecom, which offered substantial cost and quality advantages over AT&T's installed analog switching system. Digital technology threatened to erode economic barriers to entry by depreciating AT&T's sunk investments in its analog network. The second event was the Modification of Final Judgment in 1982, which split the Bell system. This regulatory reform directly undermined economic barriers to entry by proactively severing AT&T's exclusive equipment supply contracts with local telephone companies. Entry by Canadian and Japanese network equipment imports quickly followed the MFJ's adoption. In Japan, by contrast, economic barriers remained largely in place as a result of NTT's decision to delay adoption of digital switches in its local network, even as Japanese equipment producers were beginning to export digital technology. Japanese deregulation in 1985 also failed to encourage entry as it merely sanctioned competitive contracting without proactively severing existing supply relations. Asymmetries in market structure and contracting

practices that persisted after deregulation explain why entry by Japanese (and Canadian) network equipment imports quickly followed U.S. deregulation while U.S. exports responded only weakly to Japanese deregulation.

5.3.1 Economic Barriers to Entry

Network equipment differs importantly from terminal equipment in its technology and demand characteristics. The practical effect of these differences is that, while terminal equipment markets and contracting could be structured competitively, network equipment's technology and demand characteristics encourage monopolistic market structures and preferential supply arrangements that discourage competitive entry. On the production side, substantial economies of scale naturally limit the viable number of suppliers for network equipment. Variable material costs are low, while the fixed investment associated with developing and fine-tuning a line of digital switches can require a five- to ten-year expenditure of $1–$1.5 billion (Hausman and Kohlberg 1989, 203). To recover this sunk expenditure, a firm requires between a 10 and a 15 percent share of the world market in switching equipment (Huber 1987, 14–18). Scale economies have permitted the survival of just seven switch manufacturers worldwide. Each firm historically enjoyed preferential procurement ties to its national telephone service carrier: AT&T (in the United States), NEC (Japan), Northern Telecom (Canada), Siemens (Germany), Ericsson (Sweden), Alcatel (France), and Plessey (the United Kingdom).[26]

On the demand side, network complementarities imply that the network's value rises proportionately with the number of interconnected subscribers. These connections are made through central office switches, which act as the central nervous system of the telephone network. Routing telephone signals within an exchange and between exchanges requires that switches be able to communicate with one another. For this reason, telephone companies consistently rate compatibility with existing equipment as among the most important criteria when selecting their current supplier of network switches (U.S. International Trade Commission 1984, table 9). Because switches are embedded with proprietary technologies, the simplest manner for a telephone company to ensure network compatibility is to limit procurement to a small number of suppliers. Accordingly, most telephone companies historically have contracted with no more than two suppliers for central office switches (Vietor and Yoffie 1993, 138). Opportunities for recontracting occur infrequently because of the very long replacement cycle for switches. For example, the mean time between failures for AT&T's 5ESS digital switch is approximately forty years, which implies that, once a contract is let, AT&T remains strongly favored for upgrades and add-on purchases for four decades. Together, the technology and

26. Economics of scale also extend to other network equipment. For example, AT&T produces all its transmission equipment and fiber cable at a single plant in the United States, as it does for switch production.

demand characteristics of network switches strongly encourage purchasers to develop long-term, exclusive relations with their suppliers, with the result that traditional sources retain an advantage over potential entrants into a market.

5.3.2 Regulatory Barriers to Entry in the United States

Complementing these economic barriers to entry were U.S. regulatory policies that directly limited both import and export trade in network equipment. Prior to AT&T's divestiture of the local BOCs in 1982, imports remained less than 8 percent of total purchases, and exports remained below 15 percent of industry shipments (series 11 and 13).

Western Electric retained its effective monopoly over network equipment supply through 1982.[27] During this time, AT&T accounted for more than 80 percent of U.S. purchases of central office equipment, and Western Electric manufactured most of the Bell system's requirements. The remaining equipment was purchased from independent suppliers and then resold by Western Electric, acting as the BOCs' exclusive procurement agent. The 1956 consent decree sanctioned these exclusive contracts and also required the BOCs to provide Western Electric with advance notice of proposed equipment purchases. In a 1974 antitrust suit against AT&T, the government contended that this arrangement gave Western Electric sufficient lead time to preempt entry by independent suppliers.

Regulatory policy further discouraged entry into the U.S. market by establishing unique network equipment design standards. The U.S. operated under the North American standard for most switching equipment, while the rest of the world generally followed standards developed by the International Telecommunications Union. The result was the balkanization of much of the world network equipment market for an extended period. Entering the U.S. market required that a foreign manufacturer adapt its equipment to conform with U.S. standards, at a cost ranging up to $500 million for central office switches. Often, the difficulties of customizing switches for the U.S. market proved to be insurmountable. After investing several hundreds of millions of dollars trying to adapt its switch for the United States, France's Alcatel abandoned its attempts at entry (Vietor and Yoffie 1993, 138–39).

U.S. exports of network equipment likewise were limited by the 1956 consent decree, which confined AT&T to domestic, regulated markets. The decree sought to prevent AT&T from exploiting its status as a regulated service provider to cross-subsidize export sales. While an unregulated firm could not benefit from subsidizing some customers at the expense of others, AT&T could have profited by lowering its export price in the (unregulated) foreign market, shifting capital costs from those sales into its rate base, and then raising its

27. The early deregulation orders in the late 1970s (discussed in sec. 5.2) pertained only to terminal equipment contracting and therefore did not disturb the preferential supply arrangements for network equipment.

regulated price to domestic customers in order to recoup forgone export revenues. To avoid this unintended consequence of domestic regulation, the consent decree simply precluded AT&T's expansion into export markets.

5.3.3 Deregulation of the U.S. Market

In contrast to terminal equipment markets, where the removal of regulatory barriers to entry was sufficient to allow international trade to occur, trade in network equipment required reductions in *both* regulatory and economic barriers. The coincidence of a major technological advance in network switching and the forced severing of existing supply relations by regulators was responsible for opening the U.S. network equipment market to international trade.

In 1977, Northern Telecom introduced digital central office switches and sparked the first major shift in the Bell system's procurement of network equipment.[28] Digital switching represented a technological breakthrough. Compared with the Bell system's installed network of analog equipment, digital technologies made possible unprecedented advances in the quality, speed, and capacity of call routing. According to Johnson (1993, 10), Northern Telecom's lead in digital switching was so commanding that it was able to overcome the BOCs' traditional reluctance to deal with new suppliers. Between 1977 and 1980, AT&T began integrating Northern Telecom switches into its network, and U.S. real imports rose by 150 percent (series 12). Northern Telecom also established a U.S. subsidiary, Northern Telecom International, to manufacture central office switches (COSs) locally. Despite Northern Telecom's early success, however, import penetration had reached just over 7 percent by 1980, reflecting the premium that remained on preserving compatibility within the existing analog network.

Not until the MFJ fully deregulated the U.S. market in 1982 were regulatory and economic entry barriers eroded sufficiently to allow substantial U.S. import trade in network equipment. Between 1982 and 1984, import penetration jumped from 7.8 to 16.3 percent as real imports more than tripled from $319.3 to $983.3 million (fig. 5.4 above, series 12 and 13). The effect of this import surge in network equipment is seen clearly in the U.S. overall trade balance for telecommunications equipment. Figures 5.1 and 5.2 above (series 1 and 5) date 1982 as the beginning of the secular decline in the industry's aggregate trade balance.

The 1982 MFJ has been described as "the greatest unilateral removal of a non-tariff barrier in international trade history" (Robinson 1991, 438). Prior to this order, open markets for telecommunications equipment were limited to less than 15 percent of total world demand, according to OECD estimates

28. Until 1956, Northern Telecom had been controlled by AT&T and had manufactured equipment designed by Western Electric and the Bell Telephone Laboratories. When the 1956 consent decree forced Western Electric to divest its foreign operations, AT&T complied by selling Northern Telecom to Bell Canada. Ironically, regulatory policy set the stage for the eventual entry of network equipment imports into the U.S. market.

(Noam 1989, 288). The breakup of AT&T more than doubled the potential market open to foreign equipment suppliers. Deregulation severed long-standing, exclusive supply relations at the time when digital switches were just beginning to be integrated into the U.S. telecommunications network. The combination of AT&T's breakup and growing demand for digital switching thus established a window of contestability in the mid-1980s. This window provided network equipment suppliers with their first real opportunity to penetrate the U.S. market.

The terms of AT&T's divestiture of the local exchanges steered the newly created regional holding companies (RHCs) toward purchasing a greater fraction of their network equipment from foreign suppliers. The deregulation order did this in three ways. First, and most directly, AT&T was forced to sever its preferential supply relations between Western Electric and the BOCs. While Western Electric (now renamed AT&T Technologies) was permitted to continue selling network equipment, all transactions had to be at arm's-length, and the RHCs could not show preference for AT&T equipment when "other procurement conditions were roughly equal." The divestiture also barred the RHCs from vertically integrating upstream to manufacture their own network equipment. Deregulation thus disrupted two obvious sources of supply for the RHCs. The result, not unexpectedly, was a sharp decline in AT&T sales of network equipment. However, because AT&T had controlled 85 percent of the domestic market prior to deregulation, few alternative *domestic* manufacturers were available to replace those sales.[29] Thus, it was inevitable that severing the industry's existing supply arrangements would lead to a surge in *imported* equipment.

Second, the MFJ provided an additional, one-time stimulus to the RHCs' demand for digital central office switches that encouraged additional entry. To enable telephone subscribers to choose among competing long-distance carriers, the MFJ mandated that RHCs install switches that would provide "equal access" to their local network for all interexchange carriers. Existing analog switches in the Bell system could not be modified easily to provide equal access. This forced the RHCs to shift more quickly toward adopting digital switching technologies, whose flexibility allowed equal access. Again, under the terms of the MFJ, this new demand was satisfied primarily by unaffiliated suppliers, which, in the absence of significant independent domestic capacity, led to foreign entry. By the mid-1980s, however, almost all lines had been converted over to equal access, leading to a slowdown in new switch orders and, in turn, in imports.

Finally, the combination of deregulation and asset specificity in network equipment created a strategic incentive for the RHCs to diversify among suppliers. The fact that switches must be customized and carefully integrated into

29. The largest independent U.S. equipment supplier, GTE, had only a 3 percent share of the domestic digital switch market in 1982 (Crandall 1991, 84).

a telecommunications system creates the potential for postcontractual opportunistic behavior or holdups between contracting parties. The regulated Bell system solved this holdup problem through vertical integration between the dominant supplier of equipment (AT&T and its subsidiary Western Electric) and the major purchasers of equipment (the local BOCs). When deregulation split the Bell system, the potential for holdups between AT&T (as the supplier) and the RHCs (as independent purchasers) reemerged and created the strategic incentive for RHCs to diversify their equipment suppliers. The fear of holdups contributed to the RHCs' decision to purchase a greater fraction of their network equipment from foreign sources after deregulation.

Seven years after Northern Telecom's introduction of digital switches, and two years after the MFJ's implementation, import penetration in network equipment had risen to 16.3 percent (series 13). Both events played critical—and complementary—roles in opening the U.S. market to foreign trade. Their complementarity is evidenced by comparing Northern Telecom's sales before and after deregulation and by comparing sales by Northern Telecom and other foreign suppliers in the United States. While Northern Telecom's introduction of digital switches revolutionized network technology and gave the firm a potential early mover advantage, not until the MFJ severed AT&T's existing procurement contracts did Northern Telecom begin exporting switches in large volume to the United States. For example, U.S. imports from Canada (which consisted almost entirely of network equipment from Northern Telecom) rose in real terms only from $111.7 to $138.8 million between 1978 and 1981 but had grown to $342.8 million by the time the MFJ was fully implemented in 1984 (series 25). At the same time, while Northern Telecom's penetration was contingent on deregulation, its early entry into digital technology did confer an advantage over foreign competitors. For example, by 1989, Northern Telecom had grown to account for 58 percent of the import market for COSs and PBXs, while Japanese firms (NEC, Fujitsu, Toshiba, and Hitachi) held just a 19 percent share, and European firms (Siemens, Ericsson, and Mitel) held a 23 percent share.[30] In countries where telecommunications equipment systems were less extensive—and procurement relationships were less firmly entrenched—by comparison, other foreign suppliers gained dominant market shares. For example, NEC supplied 80% of Thailand's demand for COSs, 60% in Malaysia and 50% in Argentina (Vietor and Yoffie 1993, 172).

Deregulation created only a temporary window of contestability, however. This window was opened between 1982 and 1985, when U.S. demand for network equipment doubled from $3.06 to $5.99 billion (*Electronic Market Data Book* 1983, 1986). Responding to this opportunity, real imports more than tripled from $319.3 to $998.5 million during these three years (series 12). Because network switches have an average forty-year life span, however, contract opportunities again closed quickly after this date. Between 1985 and 1988,

30. My calculations, based on data in Vietor and Yoffie (1993, 162).

real demand for network equipment declined by 5 percent, real import growth slowed markedly, and the trade balance in this industry segment returned to its historical position of a small surplus.

Finally, deregulation also removed restrictions barring AT&T equipment exports that had been in place since the 1956 consent decree. AT&T was partially successful at exporting large PBXs and COSs, but export sales continued to be constrained by procurement regulations in importing markets. With the exception of the United Kingdom, which had privatized its telecommunications network in 1984, European equipment markets were not effectively deregulated until 1987, when technical standards were harmonized within the European Community and equal access requirements were mandated (Vietor and Yoffie 1993, 148–51). Thereafter, U.S. network equipment exports grew rapidly and were driven primarily by European liberalization (fig. 5.4 above, series 11).[31]

5.3.4 Regulation and Deregulation in Japan

The same regulatory policies governing Japan's terminal equipment market also covered sales of network equipment. Until 1985, NTT retained sole authority to lease and sell network equipment, which it purchased almost exclusively from a family of four suppliers headed by NEC. NTT's preferential supply relations were very similar to those negotiated between AT&T and the BOCs, although NTT itself was not vertically integrated into manufacturing. As with AT&T, these relations excluded both domestic and foreign sources of competition. Entry by independent Japanese equipment manufacturers into the approved family of suppliers were extremely rare. Likewise, as late as three years prior to deregulation, fewer than 1 percent of Japanese purchases of switching equipment were imports (Curran 1982, 194; *Japan Electronics Almanac* 1984, table 7).

In contrast to AT&T, equipment exports by the NEC family were not restricted by Japanese regulatory policy. However, exports remained limited by foreign regulatory and economic barriers. Prior to the MFJ's opening of the U.S. network equipment market in 1982, for example, only 10 percent of all Japanese switch exports were sold in the United States. (By comparison, significantly lower regulatory and economic barriers in the U.S. terminal equipment market by this date allowed Japan to sell 52 percent of these exports in the United States [*Japan Electronics Almanac* 1984, table 6].) Major destinations for Japanese switch exports were Asia and Central and South America, where telecommunications networks were less extensively developed and supply relations therefore were less firmly entrenched.

Japan's network equipment market was partially deregulated in 1985 with the passage of the NTT Company Law and the Telecommunications Business Law. Unlike deregulation three years earlier in the United States, which led to

31. Japanese exports to Europe also began rising sharply around this period, as indicated in fig. 5.7 above.

modest growth in import penetration, however, Japanese deregulation had very little effect on import trade and, in particular, on imports of U.S. network equipment. Three factors contributed to this asymmetry. First, Japanese deregulation simply withdrew government enforcement of exclusive procurement contracts without proactively severing existing supply relations. Deregulation converted NTT into a semiprivate corporation subject to competition from rivals who were not tied to the NEC equipment family. While this reform led to a gradual weakening of NEC-NTT procurement ties, it stopped well short of AT&T's divestiture of the BOCs, which both severed existing supply contracts and prompted a one-time demand surge to fulfill AT&T's equal access obligations. The NTT Company Law explicitly rejected a government commission's recommendation that NTT be forced to divest its local telephone operations in favor of new carriers (Harris 1988, 15). The result was that economic barriers to entry remained largely intact even after regulatory barriers were removed. Five years after Japanese deregulation, therefore, import penetration in switching equipment had risen to just 4.1 percent, and the U.S. share of the Japanese market had risen to just 2.9 percent (*Japan Electronics Almanac* 1993, 1994).[32]

The second factor explaining the asymmetric trade response following Japanese and U.S. deregulation stems from NTT's decision to maintain its analog switching network domestically, long after the introduction of Northern Telecom's digital switches. NEC, Fujitsu, and Hitachi each had developed digital COSs for the export market and had made preliminary sales to several regional exchanges in the United States (Hausman and Kohlberg 1989, 199). Despite the fact that these three firms also were members of the NEC family of preferred equipment suppliers in Japan, however, NTT chose to attempt to develop its own digital system for its local network. During the interim, existing analog switches remained in place. As late as 1980, only 26.7 percent of Japan's COSs had been converted over to digital, as compared to 44.6 percent of U.S. switches (McKinsey Global Institute 1992, exhibit 2E-14). the effect of this delayed introduction was to sharply limit Japanese demand for digital switches, including imported switches.

Finally, U.S. exports were hampered by Northern Telecom's earlier entry into digital technology. To the degree that Japanese deregulation opened its network equipment market to competition, entry was by Northern Telecom rather than AT&T. In the largest single procurement from a foreign supplier, AT&T lost a $250 million contract to supply central office switches to NTT for a six-year period beginning in 1987 (International Trade Administration 1986, 83). Northern Telecom's nearly ten years of production experience with digital switching provided the firm with a head start in penetrating the Japanese market.

32. For the comparable period centered around the AT&T divestiture, by comparison, U.S. import penetration for network equipment rose from 6.6 to 16.3 percent (*Electronic Market Data Book* 1982, 1990).

5.3.5 Summary

Regulatory policy played a complementary role with economic barriers to entry in shaping network equipment markets in the United States and Japan. In both countries, regulatory agencies supported business practices that sustained near monopoly control over the supply of network equipment. Deregulation led to trade only when it lowered both regulatory and economic barriers to entry. In the United States, the sequential introduction of digital switching and the proactive severing of existing supply relations met this condition. Imports rose, from both Canada and Japan, although the continuation of sunk investments in network equipment encouraged a substantially lower level of import penetration than arose in terminal equipment after deregulation. In Japan, delayed adoption of digital technologies and deregulation's failure to sever existing supply relations meant that economic barriers remained largely intact. This, combined with Northern Telecom's early mover advantage in digital switches, sharply limited U.S. exports of network equipment to Japan. The combined effect of regulatory changes in the United States and Japan, therefore, was to further expand the bilateral trade imbalance.

5.4 Lessons and Open Issues

A central conclusion of this paper is that domestic competition policy—and regulatory policy in particular—can have major repercussions for international trade. Telecommunications deregulation in the United States, and to a lesser extent in Japan, was driven primarily by domestic policy objectives and political realities (Noll and Rosenbluth 1993). Despite policy makers' inward focus, the deconcentration in market structure and opening of procurement networks that followed deregulation had profound implications for the industry's trade balance. These changes pushed telecommunications equipment to the top of the international trade policy agenda early in the Reagan administration, where it remained a source of friction between the United States and Japan for the remainder of the decade.

A second conclusion drawn from the analysis relates to the common intransigence of American and Japanese telecommunications service monopolies to accept competitive entry into equipment supply. U.S. trade negotiators have tended to overlook this commonality in order to enhance their current bargaining position. The USTR accused NTT of using discriminatory and needlessly stringent product standards to deter entry into its network and cellular equipment markets. Japan's historic reliance on stringent "voice quality" standards, in contrast to the U.S. practice of approving equipment provided that it did "no harm to the network," was a focal point of trade tensions during the MOSS negotiations. The arguments raised by U.S. trade negotiators against NTT, however, bear a striking resemblance to the complaints raised by AT&T's

would-be competitors during the 1950s. AT&T's success in excluding the innocuous Hush-a-Phone attachment for twenty years, arguing that it would harm network quality, attests to the common incentive of incumbent firms to use available regulatory barriers to maintain their monopoly position.

Finally, ongoing regulatory changes in telecommunications can be expected again to have important implications for international trade. Japan's Ministry of Posts and Telecommunications has proposed a divestiture of NTT modeled after the vertical disintegration of AT&T in 1982–84. NTT successfully resisted this reform when it was first proposed in 1985, but it now stands poised for a major reorganization in market structure and contracting ties to equipment suppliers. If these reforms are adopted, they would further erode economic barriers within Japan's telecommunications equipment market and could be expected to narrow the bilateral trade imbalance in network equipment. In the United States, passage of the proposed Telecommunications Act will expand deregulation by allowing regional telephone companies to provide long distance service and erode the regional BOCs' local service monopolies by allowing AT&T and cable television companies to enter these markets. To the extent that local service monopolies have mimicked AT&T's pre-1982 exclusionary equipment contracting practices, deregulation may further open the U.S. network equipment market to entry and international trade.

Appendix A

Table 5A.1 Industry Data

	Series 1. Telecom. Equip. Trade Balance ÷ Shipments (Fig. 5.1) (%)	Series 2. Merchandise Trade Balance ÷ GNP (Fig. 5.1) (%)	Series 3. Durables Trade Balance ÷ Shipments (Fig. 5.1) (%)	Series 4. Advanced-Technology Trade Balance (Fig. 5.2) ($millions)	Series 5. Telecom. Equip. Trade Balance (Fig. 5.2) ($millions)	Series 6. Terminal Equip. Trade Balance (Fig. 5.3) (1982 $millions)
1967	.551	.028	5.090	N.A.	17	N.A.
1968	.201	.010	2.630	N.A.	7	N.A.
1969	1.012	.051	3.310	N.A.	41	N.A.
1970	.478	.024	5.150	N.A.	24	N.A.
1971	−.472	−.024	1.090	N.A.	−24	N.A.
1972	−.247	−.013	−2.210	N.A.	−14	N.A.
1973	−.300	−.015	.460	N.A.	−18	N.A.
1974	−.111	−.006	4.640	N.A.	−7	N.A.
1975	1.989	.101	13.880	N.A.	124	−12.0
1976	2.228	.113	8.040	N.A.	150	−7.2
1977	1.750	.089	1.610	N.A.	150	−3.8
1978	1.861	.094	−1.850	N.A.	179	−32.2
1979	1.714	.087	3.380	N.A.	200	−19.7
1980	.806	.041	9.230	N.A.	100	−30.5
1981	1.745	.088	5.660	N.A.	256	−104.7
1982	1.644	.083	−.170	24,458	225	−111.8
1983	−3.881	−.196	−10.460	23,646	−542	−379.1
1984	−8.297	−.418	−20.430	20,220	−1,309	−431.1
1985	−8.483	−.427	−22.030	23,945	−1,503	−418.9
1986	−11.058	−.557	−31.040	15,640	−1,776	−820.3
1987	−13.205	−.665	−31.220	19,425	−2,183	−778.9
1988	−13.319	−.670	−24.310	27,241	−2,220	−634.7
1989	−15.587	−.784	−18.790	27,047	−2,288	−539.5
1990	−11.187	−.562	−14.370	34,081	−1,794	−689.9
1991	−13.511	−.679	−8.860	36,900	−2,065	−609.2
1992	−12.623	−.634	−11.930	33,300	−1,901	−648.8
1993	−11.049	−.554	−17.380	27,200	−1,664	−664.8

(*continued*)

Table 5A.1 (continued)

	Series 7, Terminal Equip. Exports (Fig. 5.3) (1982 $millions)	Series 8, Terminal Equip. Imports (Fig. 5.3) (1982 $millions)	Series 9, Terminal Equip. Import Penetration (%)	Series 10, Network Equip. Trade Balance (Fig. 5.4) (1982 $millions)	Series 11, Network Equip. Exports (Fig. 5.4) (1982 $millions)	Series 12, Network Equip. Imports (Fig. 5.4) (1982 $millions)
1967	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1968	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1969	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1970	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1971	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1972	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1973	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1974	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1975	2.9	14.9	N.A.	62.0	159.2	97.2
1976	5.6	12.8	1.8	68.6	163.7	95.1
1977	7.4	11.2	1.4	52.4	178.6	126.2
1978	12.0	44.1	4.5	157.1	334.7	177.6
1979	20.1	39.8	3.5	107.0	377.4	270.3
1980	25.7	56.2	5.9	117.0	435.3	318.3
1981	27.8	132.5	11.2	233.0	515.4	282.4
1982	24.2	136.0	11.6	334.2	653.5	319.3
1983	27.1	406.2	34.1	42.6	628.5	585.9
1984	35.5	466.7	37.5	−400.7	582.6	983.3
1985	35.0	453.9	29.1	−364.0	634.5	998.5
1986	34.4	854.7	55.3	−166.0	622.6	788.6
1987	58.1	836.9	80.2	−148.8	646.2	795.0
1988	183.1	817.8	86.2	109.9	992.6	882.7
1989	278.0	817.5	95.8	225.5	1,224.8	999.4
1990	174.0	863.9	96.5	143.8	1,143.5	999.7
1991	175.7	784.9	87.0	118.5	1,175.2	1,056.6
1992	197.8	846.6	88.1	202.9	1,450.0	1,247.1
1993	242.0	906.8	N.A.	N.A.	N.A.	N.A.

Table 5A.1 (continued)

	Series 13, Network Equip. Import Penetration (%)	Series 14, U.S. Trade Balance with Japan in Telecom. Equip. (Fig. 5.6) (1982 $millions)	Series 15, U.S. Exports to Japan of Telecom. Equip. (1982 $millions)	Series 16, U.S. Imports from Japan of Telecom. Equip. (1982 $millions)	Series 17, U.S. Trade Balance with Europe in Telecom. Equip. (Fig. 5.6) (1982 $millions)
1967	N.A.	N.A.	N.A.	N.A.	N.A.
1968	N.A.	N.A.	N.A.	N.A.	N.A.
1969	N.A.	N.A.	N.A.	N.A.	N.A.
1970	N.A.	N.A.	N.A.	N.A.	N.A.
1971	N.A.	N.A.	N.A.	N.A.	N.A.
1972	N.A.	N.A.	N.A.	N.A.	N.A.
1973	N.A.	N.A.	N.A.	N.A.	N.A.
1974	N.A.	N.A.	N.A.	N.A.	N.A.
1975	N.A.	N.A.	N.A.	N.A.	N.A.
1976	N.A.	N.A.	N.A.	N.A.	N.A.
1977	N.A.	N.A.	N.A.	N.A.	N.A.
1978	4.9	−124.3	8.1	133.6	27.9
1979	6.6	−112.0	17.3	129.3	63.5
1980	7.1	−221.5	20.4	241.9	95.7
1981	6.6	−257.3	22.8	281.1	85.1
1982	7.8	−331.0	25.0	356.0	90.0
1983	13.0	−539.1	29.4	568.5	71.4
1984	16.3	−1,058.6	30.7	1,088.4	60.5
1985	13.1	−1,203.6	42.2	1,245.8	78.8
1986	11.7	−1,181.5	82.5	1,264.0	82.5
1987	12.0	−1,311.0	79.3	1,390.3	104.0
1988	13.4	−1,457.8	126.2	1,584.0	171.7
1989	16.3	−1,389.1	236.4	1,625.5	300.0
1990	14.8	−1,107.1	263.7	1,370.9	456.0
1991	17.5	−1,100.6	311.9	1,412.5	351.8
1992	20.3	−1,202.7	277.3	1,480.0	444.4
1993	N.A.	−1,050.9	382.5	1,433.3	571.9

(*continued*)

Table 5A.1 (continued)

	Series 18. U.S. Exports to Europe of Telecom. Equip. (1982 $millions)	Series 19. U.S. Imports from Europe of Telecom. Equip. (1982 $millions)	Series 20. U.S. Trade Balance with Other Asia in Telecom. Equip. (Fig. 5.6) (1982 $millions)	Series 21. U.S. Exports to Other Asia of Telecom. Equip. (1982 $millions)	Series 22. U.S. Imports from Other Asia of Telecom. Equip. (1982 $millions)
1967	N.A.	N.A.	N.A.	N.A.	N.A.
1968	N.A.	N.A.	N.A.	N.A.	N.A.
1969	N.A.	N.A.	N.A.	N.A.	N.A.
1970	N.A.	N.A.	N.A.	N.A.	N.A.
1971	N.A.	N.A.	N.A.	N.A.	N.A.
1972	N.A.	N.A.	N.A.	N.A.	N.A.
1973	N.A.	N.A.	N.A.	N.A.	N.A.
1974	N.A.	N.A.	N.A.	N.A.	N.A.
1975	N.A.	N.A.	N.A.	N.A.	N.A.
1976	N.A.	N.A.	N.A.	N.A.	N.A.
1977	N.A.	N.A.	N.A.	N.A.	N.A.
1978	60.4	32.5	33.7	59.2	26.7
1979	92.4	28.9	61.2	88.9	27.7
1980	128.0	32.3	111.8	155.9	44.1
1981	113.1	28.0	127.6	197.1	69.5
1982	130.0	40.0	81.0	255.0	174.0
1983	118.4	47.0	−249.5	275.9	524.5
1984	138.3	77.8	−307.4	216.1	523.5
1985	200.8	122.0	−215.8	223.3	439.0
1986	206.2	124.7	−520.6	209.9	731.4
1987	221.1	117.2	−733.9	187.7	921.6
1988	329.7	158.9	−872.8	304.3	1,177.1
1989	448.2	148.2	−1,137.3	410.9	1,548.2
1990	642.9	186.8	−1,133.7	518.3	1,652.0
1991	616.5	263.8	−1,356.3	392.6	1,748.9
1992	729.8	285.3	−1,336.0	484.4	1,820.4
1993	878.9	307.9	−1,671.1	469.3	2,140.4

Table 5A.1 (continued)

	Series 23, U.S. Trade Balance with Canada in Telecom. Equip. (Fig. 5.6) (1982 $millions)	Series 24, U.S. Exports to Canada of Telecom. Equip. (1982 $millions)	Series 25, U.S. Imports from Canada of Telecom. Equip. (1982 $millions)	Series 26, Japan Trade Balance with U.S. in Telecom. Equip. (Fig. 5.7) (1982 $millions)	Series 27, Japan Trade Balance with Europe in Telecom. Equip. (Fig. 5.7) (1982 $millions)	Series 28, U.S. Labor Cost (Fig. 5.8) ($/hour)
1967	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1968	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1969	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1970	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1971	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1972	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1973	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1974	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1975	N.A.	N.A.	N.A.	N.A.	N.A.	6.36
1976	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1977	N.A.	N.A.	N.A.	N.A.	N.A.	7.59
1978	−27.0	84.6	111.7	86.4	53.5	8.27
1979	−66.8	89.5	156.3	200.0	85.7	9.02
1980	−125.6	98.1	223.7	239.1	129.1	9.84
1981	.2	138.9	138.8	419.5	172.0	10.84
1982	−7.8	119.8	127.6	407.5	162.6	11.64
1983	−121.5	108.0	229.4	793.5	175.8	12.10
1984	−221.5	121.3	342.8	1,308.4	251.1	12.51
1985	−260.9	122.2	383.1	985.6	302.9	12.96
1986	−197.7	118.1	315.8	1,123.5	588.9	13.21
1987	−132.2	157.6	289.7	1,366.7	1,020.6	13.46
1988	−217.8	172.2	390.0	1,956.8	1,715.9	13.91
1989	−188.2	206.1	394.3	1,559.5	1,458.7	14.32
1990	−183.0	287.8	470.8	1,258.7	1,415.9	14.91
1991	−122.3	406.0	528.3	1,293.9	1,444.2	15.60
1992	−47.6	595.9	643.5	1,642.5	1,456.0	16.17
1993	120.6	770.8	650.2	N.A.	N.A.	N.A.

(*continued*)

Table 5A.1 (continued)

	Series 29. Japan Labor Cost (Fig. 5.8) ($/hour)	Series 30. S. Korea Labor Cost (Fig. 5.8) ($/hour)	Series 31. Taiwan Labor Cost (Fig. 5.8) ($/hour)	Series 32. Hong Kong Labor Cost (Fig. 5.8) ($/hour)
1967	N.A.	N.A.	N.A.	N.A.
1968	N.A.	N.A.	N.A.	N.A.
1969	N.A.	N.A.	N.A.	N.A.
1970	N.A.	N.A.	N.A.	N.A.
1971	N.A.	N.A.	N.A.	N.A.
1972	N.A.	N.A.	N.A.	N.A.
1973	N.A.	N.A.	N.A.	N.A.
1974	N.A.	N.A.	N.A.	N.A.
1975	3.05	.34	.39	.76
1976	N.A.	N.A.	N.A.	N.A.
1977	4.02	.59	.52	1.03
1978	5.54	.80	.61	1.18
1979	5.49	1.06	.78	1.31
1980	5.61	1.01	.98	1.51
1981	6.18	1.06	1.18	1.55
1982	5.70	1.13	1.22	1.67
1983	6.13	1.20	1.27	1.52
1984	6.34	1.28	1.48	1.60
1985	6.47	1.31	1.46	1.75
1986	9.47	1.39	1.67	1.89
1987	11.34	1.69	2.23	2.11
1988	12.63	2.30	2.82	2.40
1989	12.49	3.34	3.53	2.79
1990	12.74	3.88	3.95	3.20
1991	14.55	4.39	4.39	3.58
1992	15.16	4.93	5.19	3.89
1993	N.A.	N.A.	N.A.	N.A.

Sources: Series (1): *U.S. Industrial Outlook* (1970–94). Series (2): *Statistical Abstract of the United States* (1971, 1981, 1994). Series (3): Citibase (New York), main data tape, series GEXMD, GIMMD, and MDS. Series (4): U.S. General Accounting Office (1992); *Statistical Abstract of the United States* (1994). Series (5): *U.S. Industrial Outlook* (1982–94). Series (6)–(13): *Electronic Market Data Book* (1975–94). Series (14)–(25): *U.S. Industrial Outlook* (1978–94). Series (26)–(27): *Japan Electronics Almanac* (1981–94). Series (28)–(32): *International Comparisons of Hourly Compensation Costs for Production Workers in Manufacturing* (1988, 1993).

Appendix B

Table 5B.1 Major U.S. and Japanese Regulatory Actions Affecting Telecommunications Equipment

Date	Action	Significance
1956	AT&T consent decree	Agreement ending antitrust complaint allowed AT&T and Western Electric to remain vertically integrated, required AT&T to license all patents, and restricted AT&T to regulated activities in the domestic market
1956	Hush-a-Phone order	FCC permitted attachment of this independent device to telephones, but AT&T blocked implementation
1968	Carterphone order	FCC permitted customer-owned equipment to be connected to network but allowed AT&T to charge a discriminatory fee to those customers
1974	Antitrust case filed against AT&T	Department of Justice seeks to split AT&T from Western Electric (eventually settled by 1982 Modification of Final Judgment)
1975	First order registration program	FCC clarified standards for certifying independent attachments but excluded telephone sets, key sets, and PBXs; AT&T delays implementation for two years
1977	Second order registration program	Extends 1974 program to apply to telephones, key sets, and PBXs; independent equipment can be attached after certifying that it poses "no harm" to the network
1980	Computer II Inquiry	FCC removed terminal equipment from rate-of-return regulation and required AT&T to sell equipment through a separate subsidiary
1981	Understanding on the Interconnect Market (Japan)	Following partial deregulation of Japan's terminal equipment (interconnect) market, NTT liberalized certification procedures for independent equipment
1982	Modification of Final Judgment announced	Agreement ending 1974 antitrust complaint required AT&T to divest Bell operating companies (BOCs), severed AT&T's exclusive equipment supply contracts with BOCs, and organized BOCs into regional holding companies (RHCs) and barred them from manufacturing equipment
1984	Modification of Final Judgment's implementation completed	Implementation of Modification of Final Judgment completed on 1 January 1984
1985	Telecommunications Business and NTT Company Laws (Japan)	Deregulation of Japanese terminal and network equipment markets that rescinds NTT's monopoly over first telephone, establishes independent standards-setting board, and partially privatizes NTT subject to competition from rivals not tied to NEC's equipment family

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