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Summary

Domestically as well as internationally, services and manufacturing depend on one another. Given the size and diversity of the U.S. economy, any view of the future that sees the services taking the place of manufacturing has pushed the distinctions between them too far. As this assessment shows, there is no choice to be made between a manufacturing economy and a service economy. The choices concern the pace of change and the kinds of skills that Americans will need to work productively in emerging industries. They also concern Federal policies to aid and assist the adjustments involved, and an international trade regime that will permit the synergies between domestic and foreign production, goods and services, American know-how and foreign know-how, to multiply. Among the most critical policy choices will be those affecting Americans who lack the skills for full participation in the kind of economy that will emerge over the next 30 years.

The international infrastructure for services has become critical for the long-term competitiveness of U.S. firms in *many* industries. More than 70 percent of all Americans work in the service sector of the economy (table 32, ch. 7). In nations otherwise as different as the United States, Japan and the United Kingdom, more people find jobs in service industries than in manufacturing, and services account for more than half of gross domestic product. Many governments have instituted policies, often including trade protection, to encourage growth in the intermediate or business services that form a primary subject of this assessment.

Still, while the services make a significant contribution to the U.S. balance of payments, direct trade in manufacturing remains much larger. The share of services in *total* world trade has remained more-or-less constant at 17 to 18 percent over the past 15 years. Thus the dominance of services domestically—in terms of employment and share of gross output—does not carry over to the international trade arena. Even so, beginning in *1982,* the U.S. Government made reductions of trade barriers in services the centerpiece of its proposals for a new round of multilateral trade negotiations (box A). These proposals were opposed in parts of the developing world. As preparations continued, the emphasis on services receded only slightly; the Uruguay Round, initiated in September 1986, gives them a prominent place. Why did the United States raise the negotiating stakes so high? Why did other nations react as they have? Does it make sense to press for international agreements on services at a time of deteriorating trade relations generally? As this report will show, the answers to such questions depend as much on the interrelationships of the services and manufacturing as on the magnitude of service exports themselves.

This assessment, requested by the Senate Committees on Governmental Affairs and Foreign Relations, and by the House Committee on Small Business, looks with particular care at four services:

- banking (ch. 3);
- engineering and construction (E&C, ch. 4);
- information technology (IT) services, including most services related to data processing and communications, but not equipment (ch. 5); and
- technical licensing (a source of revenues for manufacturing firms almost exclusively, ch. 6).

Beyond specific expressions of interest by the requesting Committees, the reasons for choosing these four sectors included dependence on technology and its significance for international competition, and dollar value of transactions as recorded in the U.S. balance of payments. All four have strategic importance, in part because they are intermediate services provided mostly to other businesses. This means that competitive strength can create a powerful if indirect stimulus for other parts of the U.S. economy—as when multinational manufacturing companies make use of international com-

Box A.-Services in the New TradeRound

In September *1986,* trade officials from most of the 90-plus members of the General Agreement on Tariffs and Trade (GATT, the principal organization within which governments negotiate the rules for world trade] agreed on plans for a new round of multilateral trade negotiations (MTN)—to be known as the Uruguay Round. Since 1982, the United States had been pressing for an MTN round that would address barriers to services trade (ch. 9). Other "new issues" rose in prominence as preliminary discussions continued. Respite ongoing opposition from a group of developing nations, led by Brazil and India, must of the new issues raised by the United States will be part of the Uruguay Round negotiations, although nut necessarily as prominent as the United States might have wished. In addition to services, these include restrictions on foreign direct investment that may distort trade flows (most simply, performance requirements that make exporting a condition for inward investment) and protection for intellectual property (strengthening of patents and copyrights, stiffer enforcement of laws prohibiting counterfeiting of goods).

To begin the process of liberalizing trade in services, the United States has sought the following:

- Agreement that "national treatment" should, in general, govern services trade. For most of the services, this principle-that foreign firms should be treated the same as domestic (national) firms-implies the right of establishment.
- "Transparency" in regulations and barriers that affect services trade—i.e., explicit rather than hidden rules.
- GATT procedures for resolving disputes concerning trade in services.

Given a satisfactory umbrella agreement incorporating such provisions, GATT parties might (or might not) 'move on to negotiations dealing with particular service industries during the Uruguay Round.

While the United States got most of what it wanted in the 1986 Ministerial Statement, services negotiations will take place in parallel with, rather than as part of, negotiations on goods trade. This concession to the developing countries—which argue that services do not belong in GATT at all, but should be discussed in other international bodies--may make it more difficult to eventually integrate whatever agreements are reached into the structure of GATT codes and adjudication mechanisms. On the other hand, there are good reasons, as discussed later in this repro% for pursuing negotiations on services in other multilateral forums as a supplement to the GATT talks, and also for bilateral discussions on services.

The Uruguay Round is scheduled to run through 1990, but it seems quite possible, given the complexity of the issues to he negotiated, that 4 years will not be enough to reach meaningful agreements; this set of trade talks could easily continue well into the 1990s. The process of bringing services trade under GATT discipline will be a difficult one, for two closely related reasons. First, many Of the services in many countries have been heavily regulated for years (examples include banking and insurance). State ownership has also been common (air travel, telecommunications). Second, almost all the trade and investment restrictions are non-tariff in nature. Many governments design their regulatory and supervisory policies to exclude foreign firms or favor domestic firms. The preceding Tokyo Round took up non-tariff barriers affecting trade in goods; progress proved painfully slow. When it comes to many of the services, sensitivities will be even higher, if only because openness to trade implies rights of establishment and hence inward investment.

munications networks to manage global operations. Because this assessment deals with international competitiveness, most of the analysis centers on businesses, Sometimes the interests of U.S. companies correspond to the interests of other groups or the Nation as a whole, sometimes not, But it is business organizations that compete internationally—not governments, not people (as consumers, as workers), not entire economies.

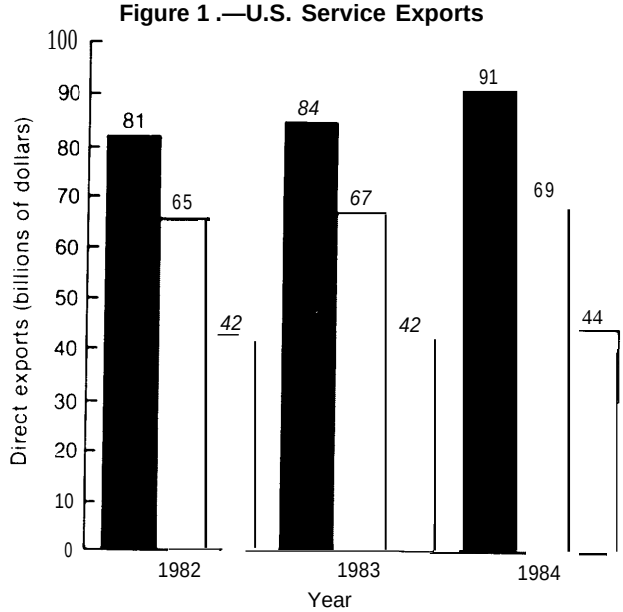
PRINCIPAL FINDINGS

Services and the U.S. Economy

1. OTA's estimates show that services make a greater contribution to the U.S. balance of payments than the official figures imply—a surplus of perhaps $14 billion in 1984, rather than only $2.3 billion. Services account for about one-quarter of U.S. exports, substantially more than the 17 percent indicated by official government statistics (figure 1).[1] But while services help the U.S. trade position more than had been realized, OTA finds no reason to expect that exports of services will grow more rapidly than exports of goods; the ratio of service exports to total exports will probably not change very much over the next decade or two, *Trade in services will remain considerably smaller than trade in goods;* services may have a dominant place in domestic employment and production, but not in international trade (figure 2).

2. *Relatively few American jobs depend directly on trade in services,* Not only does domestic production of services greatly exceed exports and imports of services, but U. S.-based service firms do more overseas business through foreign affiliates than through direct exporting, Investment abroad means jobs in foreign countries. (And foreign investment in the United States means jobs here,) Almost certainly, services embodied in U.S. goods exports contribute more to U.S. employment than do exports of services,

Figure 1 .—U.S. Service Exports



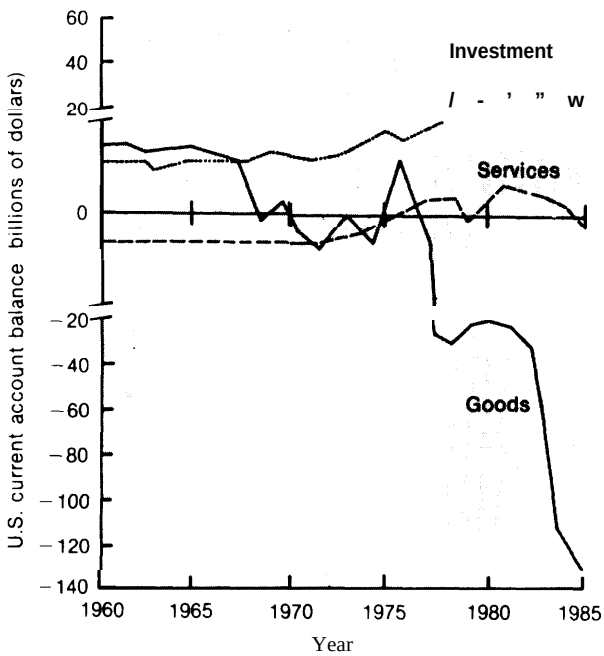
[a]Bureau of Economic Analysis, Department of Commerce

SOURCES: *Trade in Services: Exports and Foreign Revenues* (Washington, DC Off Ice of Technology Assessment, September 1988), p 39, R C Krueger, "U S International Transactions First Quarter 1986, " *Survey of* Current Business, June 1986, pp *3670*

The need to produce services at the point of consumption limits growth prospects for exports, in contrast to goods, which can be shipped and stored. Although advances in communications and transportation have made it easier and cheaper to supply services at a distance, the changes are incremental, with no real prospect of radical transformation. In general, when U.S.-based firms establish overseas affiliates in the services, these affiliates are staffed by local people and purchase in the local market,

[1]The $14 billion figure corresponds to the middle of the range of OTA's estimates. For 1984, OTA places U.S. exports of services, excluding banking, at $69 billion to $9 I billion. Merchandise exports that year came to $220 billion, The ratio of the midrange figure for services to all exports equals 0,27. Based on the official Federal Government figure for 1984 service exports, $43.8 billion, services come to only 17 percent of all exports. See *Trade in Services: Exports and Foreign Revenues* (Washington, DC: Office of Technology Assessment, September 1986), p. 38.

Figure 2.— U.S. Trade Balance According to Official Government Figures



SOURCE: R.C. Krueger, "U S International Transactions, First Quarter 1986, " Survey of *Current Business,* June 1986, pp 42-43

3. While overseas investments may not contribute very directly to U.S. jobs, exports, or international competitiveness, the indirect and strategic benefits to the Nation economy can be substantial.

American multinationals—whether they produce services, goods, or both–stand to benefit from further opening of trade and investment opportunities in the services. These benefits will come in part from a better developed global infrastructure for supporting their business activities: deeper and more integrated capital markets; well-established and comfortable working relationships with the overseas affiliates of the accounting firms, advertising agencies, insurance companies, and law firms that they deal with at home; cheap and reliable communications networks. The synergies and strategic benefits flowing from such an infrastructure can aid U.S. economic growth and competitiveness, and create new domestic jobs, even though impacts within the United States may be hard to trace.

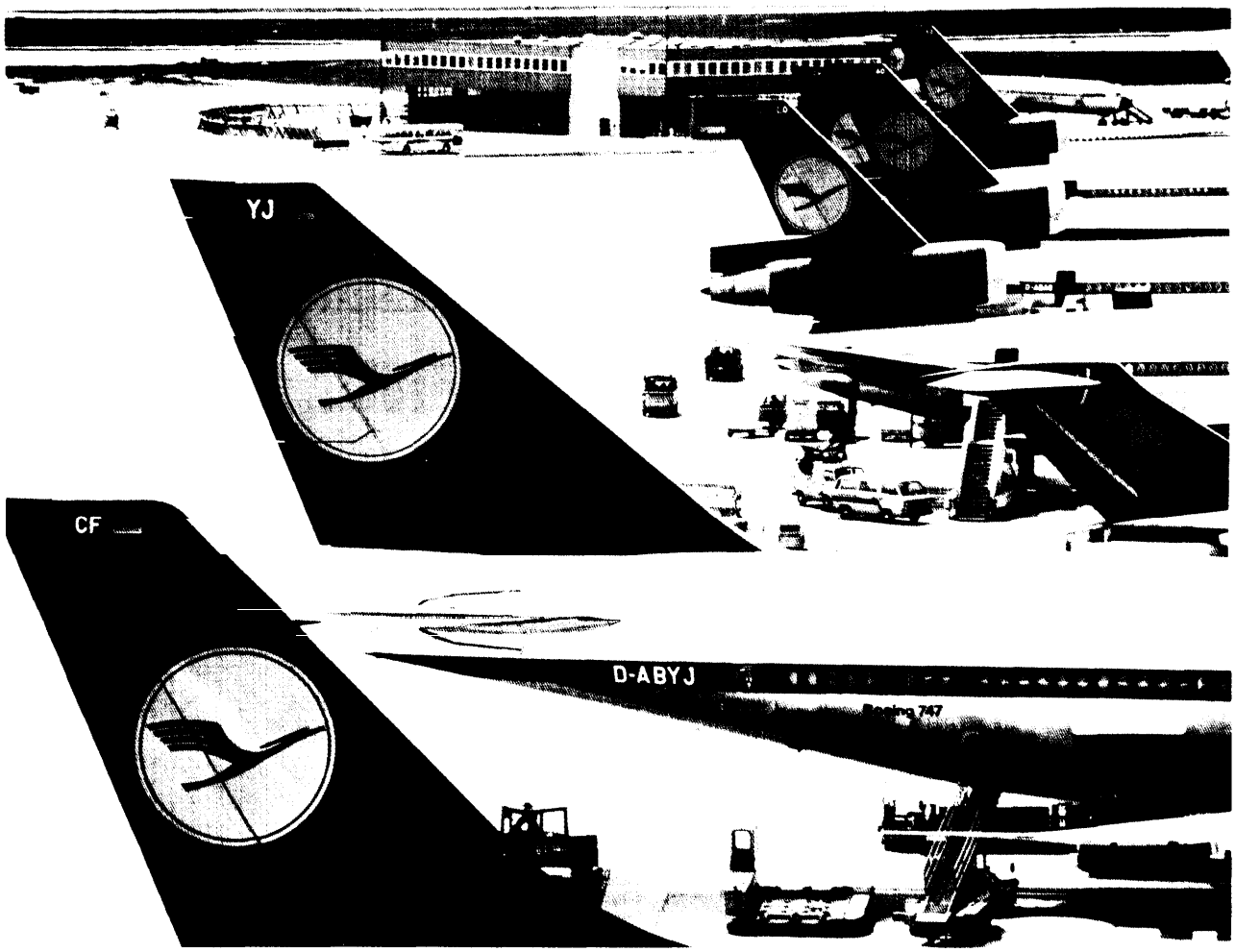
4. International competitiveness in high-value-added manufactured goods (e.g., computers or commercial aircraft) depends on knowledge-based services—computer software, engineering, banking and finance, business services of all kinds, *To maintain a society with high living standards and large numbers of well-paying jobs, the United States must remain competitive in both high-value-added goods and knowledge-based services;* this, in turn, requires a well-educated and highly skilled labor force, one that can adapt to changing competitive conditions.

5. Government policies, particularly regulatory policies, have greater impacts on many service industries than on goods-producing industries. Sometimes these policies help the international competitiveness of American firms, sometimes they hurt. But impacts on competitiveness seldom get much attention from policymakers. Given the increasing integration of the U.S. and world economies, *Federal agencies with regulatory or supervisory authority over the services will have to begin paying consistent attention to international competitiveness.* If they do not, the competitive ability of American service firms may begin to suffer. If U.S. service industries suffer the same kinds of competitive declines as U.S. manufacturing industries, the Nation's living standards will be in even greater danger,

The U.S. Competitive Position

1. Internationally, *the United States maintains a position of competitive advantage in most* services—although U.S. competitiveness varies a good deal among these industries. Some —e. g., engineering and construction—have been slipping. Others, notably the information-related services, remain highly competitive. (Industry-specific findings appear later in this chapter.)

Figure 3 compares the U.S. balance of payments in services, according to the official figures, with that in goods, The chart shows that the United States ran large deficits in goods



Phofo credlit: Lufthansa

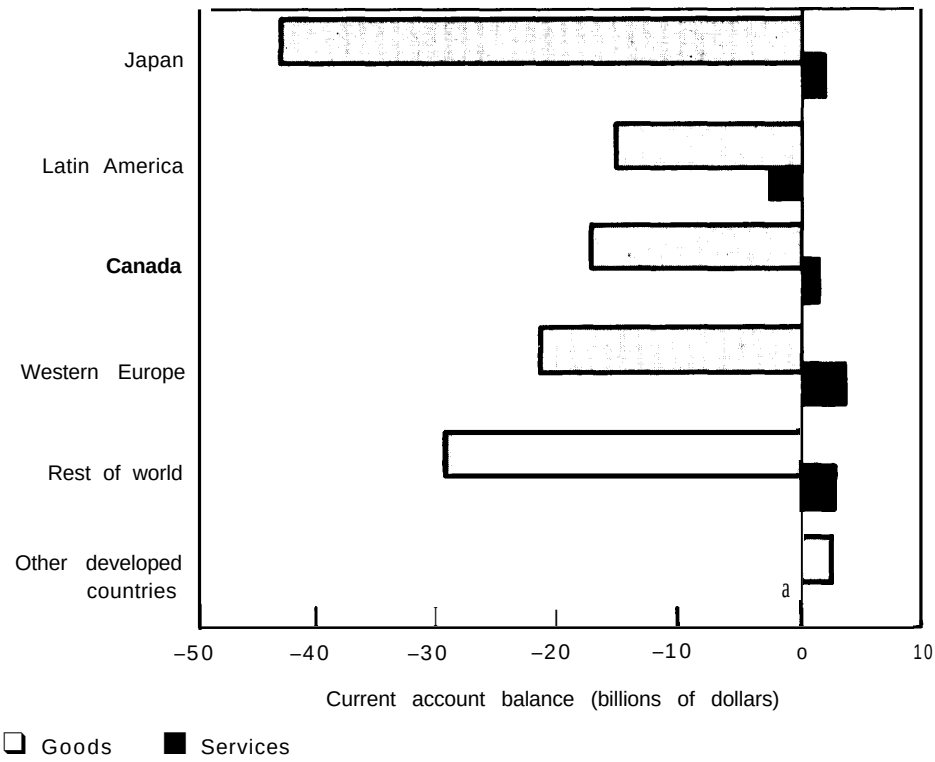
American jetliners, part of Lufthansa's fleet, at Frankfort airport

trade with almost all regions of the world in 1985, coupled with surpluses in services—albeit small—everywhere but Latin America (where tourist travel by Americans pushes the balance to the deficit side). The official figures underestimate U.S. exports and imports of services, but are the only source of comprehensive geographic detail; more accurate data would disclose somewhat larger surpluses with most regions.

2. The U.S. surplus on services trade has fallen–according to OTA's midrange estimates, from about $20 billion in 1982 to $14 billion in 1984. As for trade in goods, some of this decline reflects the strength of the dollar, but in *many of the service industries, as in manufacturing, continuing economic growth and development have helped other countries* narrow *the gap with the United States*. For example, E&C firms in both the newly industrializing and less developed countries (NICs and LDCs) have made substantial strides in their technological and managerial capability over the past 15 years.

3. As in so many manufacturing industries, *many of the future competitive threats in the services will come from Japanese firms,* Japan has already proven its competitive ability in

Figure 3.–U.S. Trade Balance by Region, 1985



[a]Services balance with "other developed countries" = $0.26 billion

NOTE: The sum of the balances in the figure does not equal the 1985 current account deficit because the current account includes other items not in the chart (investment income, government transactions, and unilateral transfers)

SOURCE: R.C. Krueger, "International Transactions, First Quarter 1986," Survey of *Current Business*, June 1986, pp. 36-70.

computer hardware and in telecommunications equipment. Improvements in services ranging from software products to computer and communications networks will follow, if at first only to meet Japan's own needs and to take advantage of the country's expanding hardware base. This coming thrust into information-based services promises to boost Japan's international competitiveness still further in *manufacturing.*

Japanese E&C firms have long since demonstrated their competitive ability. The banks, as discussed below, have been following Japanese manufacturers into international markets, aided by the capital reserves accumulating as a result of huge trade surpluses; if Japanese banks succeed in taking competitive advantage of their asset base, they could quickly take on still more prominent roles in world financial markets.

Finally, Japan's policymaking system seems more attuned than those of Western governments to the needs and consequences of the shift toward an information-centered economy. To this point, policy makers and bureaucrats in Japan have tended to view competitiveness in services as flowing from competitiveness in manufacturing, But they also recognize that the Japanese economy faces an eventual transition from mass production of consumer durables to a structure centered on information technologies. Government officials in Japan are doing

their best to lay the groundwork for a competitive set of industries in the future, as their economy emerges from this transition.

Negotiations on Trade in Services

1. The United States has made reductions in barriers to services trade a primary goal in the Uruguay Round trade talks, Although immediate payoffs in terms of U.S. jobs and U.S. exports will be small, the *long-run strategic importance of services makes the goal a vital one.* The negotiations promise to be lengthy and difficult: far more often than in manufacturing, trade (and investment) barriers in the services —almost always non-tariff in nature—have domestic policy rationales.

Governments regulate banking and insurance to protect consumers; many countries view telecommunications as having elements of natural monopoly. Such factors raise sensitivities several notches above those associated with non-tariff barriers (NTBs) affecting trade in goods. It is easy for governments to tilt the regulatory and supervisory policies that affect service industries to make life difficult for foreign firms. Past GATT negotiations aimed at reducing NTBs affecting goods have proved less successful than hoped. With a great deal of room for maneuver and for ambiguity, it will take patience and persistence to reach meaningful agreements on barriers to services trade, inside or outside of GATT.

2. No matter the perspective from which the service industries are viewed, differences seem to outweigh similarities, even among the knowledge-based intermediate services that form the primary subject of this assessment. Generalizations concerning the international competitiveness of U.S. service industries cannot be pushed too far. Government policies, here and overseas, affect them in different ways; measures that help one may hurt another. Liberalization would benefit some U.S. industries more than others. The lists of those helped and those harmed will differ among countries.

Any negotiating strategy for the service industries, in either a bilateral or a multilateral framework, must be based on a well-founded analytical grasp of the differences among them. Lacking such a grasp risks outcomes that, on balance, would do more harm than good to U.S. interests. Even given such an understanding—difficult to develop, if for no other reason than the gaps in the data from which analysis must begin—a *multilateral trade agreement embracing the services will almost certainly mean diminished competitive prospects for some U.S. service industries, along with brighter prospects for others.*

3. U.S. policy makers will be faced with decisions on which topics will be most appropriate for GATT and which for other venues (e.g., the Organization for Economic Cooperation and Development, bilateral negotiations, specialized organizations). Longstanding international arrangements exist for services including shipping, air travel, and telecommunications. Bodies like the World Intellectual Property Organization will continue to provide a forum for negotiations on intellectual property protection, Decisions on international technical standards could have considerable impact on trade and investment in the decades ahead, *Choosing the right mix of topics in the right mix of forums would be a major step toward a trade policy that is forward-looking rather than reactive.*

The process entails more than monitoring foreign government actions (and seeking to learn from foreign experience). The United States also needs to monitor and adjust its own policies, As chapters 9 and 10 make plain, the list of policy issues that affect trade and competition in the services is a long one. The issues range from very general—the ability of the Federal Government, as currently organized, to cope with economic interdependence, new patterns of international business, and continuing pressures for domestic adjustment—to quite specific, such as illegal copying of computer soft ware.

4. Other governments, particularly in the developing world, have often viewed the U.S. push on services as forcing them into a battle they will probably lose. They will seek conces-

sions on trade in goods in return for liberalization in services.

Given a massive U. S. deficit in goods trade, which a falling dollar will help but not eliminate, policy makers and trade negotiators will have to balance priorities, not only among the services, but between services and goods. Trade agreements always lead to winners and losers, if for no other reason than that some nations and some industries benefit more than others; in a very real sense, services and goods compete with one another. *To get agreements that it wants in services, the United States will undoubtedly have to make concessions elsewhere.*

U.S. negotiators will need to seek advice and guidance from a wide range of potentially affected interests, particularly if the Uruguay Round negotiations go beyond an umbrella agreement to sector-specific issues. New advisory mechanisms may be needed to bring services-related negotiations to a satisfactory conclusion. Government agencies charged with conducting the negotiations, notably the Office of the U.S. Trade Representative (USTR), may well require added resources.

5. OTA finds no compelling reason, at this time, to give either bilateral or multilateral negotiations in particular service sectors unusually high priority. Of those services with clear strategic importance for leveraging U.S. exports and spurring economic growth, *telecommunications services and computer software come closest to meriting special consideration.*

In some contrast, international banking, alone among the services, seems to carry the potential for severe *disruptive* impacts, and hence for economic dislocations potentially comparable, say, to the oil shocks of the 1970s. Here, however, continuing steps aimed at preserving stability are likely to take place quite independent of GATT.

6. In part because more nations have been evading the intent and sometimes the letter of GATT codes, the ability of the system to manage trade in goods has deteriorated. The strains will probably continue to build. Countries with heavy debt burdens need to find foreign markets for their goods, but face new restrictions in many industrial nations, including the United States. At the same time, many of these developing countries see their relatively small service sectors as vulnerable to foreign competition and in need of protection. They may feel there is little to be gained from agreements on services trade, unless accompanied by an opening of markets for their goods,

With the United States and other industrialized nations, as well as the developing countries, more heavily dependent on trade in goods than services—and with the United States already having large shares of many service markets—aggressive pursuit of services agreements could harm prospects for improving the ability of the trading system to cope with strains over trade in goods. U.S. negotiating objectives may have to adapt to this reality as the Uruguay Round continues. Unless GATT as an institution can be substantially strengthened, its disciplinary force will continue to wane; *GATT could become irrelevant.*

Trade and Competition by Sector

Banking and Financial Services

International banking (ch. 3)—only loosely similar to the retail financial services familiar to most Americans—has been growing rapidly, fueled by deregulation and new products, many of them possible only because of developments in computer and telecommunications technologies. Examples range from 24-hour securities trading to the lightly regulated offshore markets for products like Eurobonds. With lending less profitable in recent years, banks have turned to new and largely unregulated products in part to earn fees for services. The offshore markets—in essence, operating outside the regulatory reach of national governments—have been expanding at literally explosive rates. Growth in securitization means that almost any financial instrument—e.g., commercial paper, bundles of mortgages–can now be traded. Larger corporations can market their own secu-

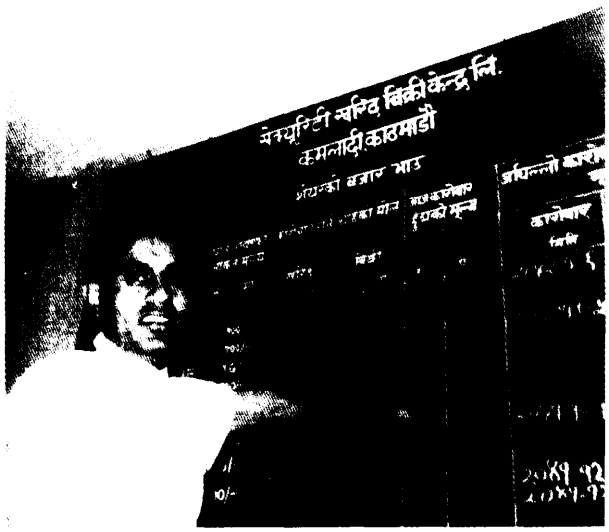


Photo credit: Steven Weissman, NYT Pictures

Stock exchange in India

rities, manage their own short-term assets. When they do so, they are in effect competing with their banks, Taken together, these developments raise new questions concerning the safety and stability of the international banking system.

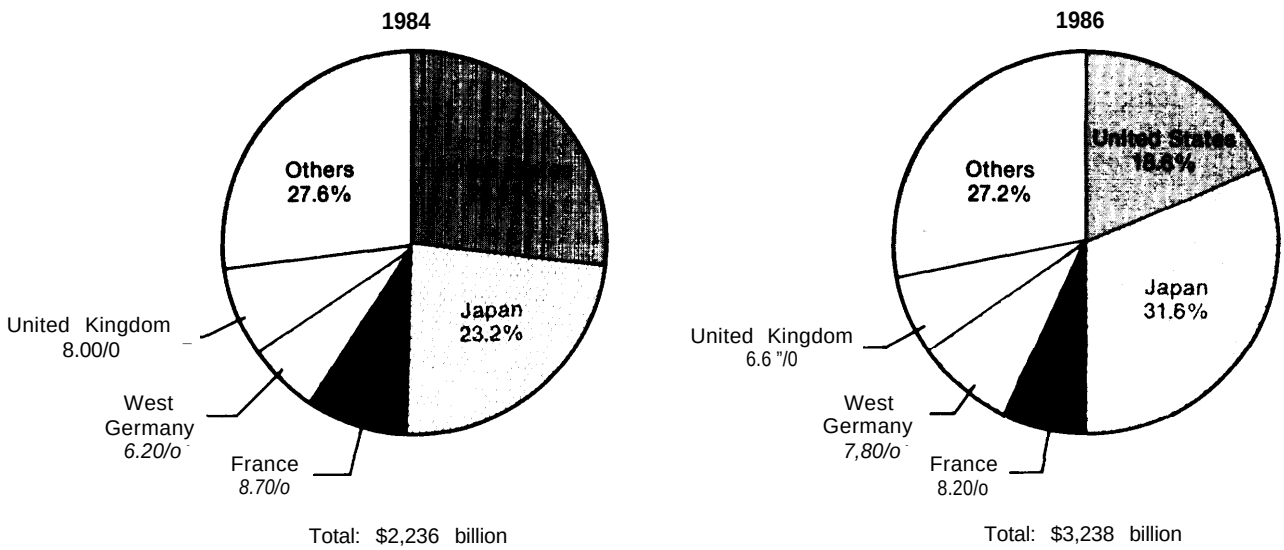
Deregulation means more competition, driving down profits. Banks seek new products and new international markets in part to maintain their profit margins. Deregulation becomes contagious. When one nation relaxes its supervisory authority, others must follow, else risk losing business. But deregulation cannot go too far without threatening the stability of the system,

In the United States, regulatory and supervisory authorities find that more of their decisions have international ramifications. Impacts on international competitiveness must be built into decisonmaking processes.

This is an industry, then, with intense competition among financial institutions in many countries, one where substantial advantages are hard to come by. American banks have done well, in part because of their accumulated experience in a relatively open market. Only Japanese banks, with their rapidly growing financial muscle—in large part a legacy of Japan's vast trade surplus in manufactured products—have mounted a real challenge (figure 4),

1. Internationally, a great deal of momentum drives the technology that leads to innovations

Figure 4.— International Assets of Major Banks by Country



NOTE Figures are for September of each year

SOURCE A Nicoll Japanese Bank Lending Surges Ahead *Financial Times*, Jan 20, 1987 p 22 Original source Bank for International Settlements

in financial service products, to market growth, and to pressures for deregulation. The changes *taking place raise new concerns for the safety of the international banking system.* Electronic networks move huge sums of money around the world almost instantaneously. Where once regulatory authorities could expect to see warning signs days or weeks before a bank failed, now the process could be over before the authorities charged with safeguarding the system are able to react. Innovation in financial services will continue, in rather unpredictable directions. Regulatory and supervisory bodies will have to cope with dynamic, rapidly changing conditions, nationally and internationally, for the foreseeable future.

2. Despite the bad loans they have made internationally, *U.S. financial services firms, as a group, remain highly competitive.* Banks in other countries have their share of problem loans, while American firms have been leaders in new financial services and innovative applications of technology—many of the latter helping them escape the regulatory thrusts of national governments. As other countries deregulate, American banks will continue to take advantage of their learning and experience here to penetrate foreign markets. Nonetheless, some U.S. financial services firms will make mistakes and find themselves in competitive difficulty; some may fail or be purchased by more successful rivals.

3. Among national banking industries, *only the Japanese have mounted a real threat to the United States in financial services.* Japanese banks followed Japanese manufacturing firms onto the world stage. Japan now can claim most of the biggest banks in the world, as measured by assets. The speed with which Japanese financial institutions turn new opportunities into competitive reality—and the magnitude of the competitive threat to U.S. banks—depends first of all on the speed of deregulation in Japan's *domestic* financial markets. The faster Japan's Government liberalizes at home, the freer Japanese banks will be to compete overseas.

4. While U.S. financial services firms have been moving into overseas markets, foreign banks have moved into the United States. In both retail and commercial banking, *some foreign banks* will be quite *successful in the* United *States, but this in itself should not be taken as a sign of flagging U.S. competitiveness.* It is, rather, a natural consequence of an open and attractive market, with fewer regulatory restrictions than in the past. Foreign banks come here in part because of the size of U.S. markets, in part because their corporate clients have invested in the United States, in part because they seek experience in a deregulated and highly competitive environment.

5. To considerable extent, U.S. banking regulations have been overtaken by events. Many of the regulatory barriers—e. g., those separating commercial from investment banking—seem bound to crumble further. While regulations will continue to have significant effects on competitive outcomes internationally, most of these are secondary and indirect—hard to trace and hard to predict. This real but less than obvious influence is precisely the reason that *policymakers and regulators in the United States will have to take far greater account of the ramifications of their decisions for international competitiveness in banking.* Financial services is plainly an industry that, in its domestic as well as its international dimensions, will challenge the creativity of regulators as well as bankers.

Sometimes U.S. regulations give foreign banks advantages, and in other cases American banks come out ahead, but there are few cases of major asymmetries and little cause for wholesale reassessment of U.S. banking policy because of international competition. Rather, given the expansion and growing integration of world financial markets, U.S. policy makers need to build international considerations into their routine processes.

6. Governments and banks have special relationships all over the world. Regulatory and su-

pervisory policies aim at ensuring stability and protecting depositors. Governments implement monetary policy through the banking system, and, in some countries, use it to allocate credit and guide economic development.

With new technologies and new products making it easier for banks to circumvent the regulations that remain, and with competition inducing financial institutions to take greater risks in order to maintain their profit margins, *continued movement toward international coordination of banking regulations seems necessary to ensure stability*. The competitive trends analyzed in chapter 3 point to a need for ongoing discussions aimed at harmonization and coordination of regulatory and supervisory policies among major banking nations. The international regime for banking looks markedly underdeveloped compared with that for service industries like telecommunications. Indeed, despite the sensitivities raised by the special relationships between banks and national governments, it maybe time to consider supranational regulation of financial services, rather than simply coordinated national policies.

Engineering and Construction

While international banking has been growing, the international E&C market has been shrinking (ch. 4). Falling oil prices and Third World debt burdens marked the end of a period of vast international projects, one that brought abundant opportunities for both American and foreign E&C firms. Today, foreign contractors often have technology as good as—in some cases, better than—American firms, European and Japanese contractors have pioneered new approaches to tunneling and reinforced concrete construction. South Korean construction companies learned their trade in Vietnam and the Middle East during the 1960s and 1970s, often working alongside American firms.

The result? More competition for fewer projects, and a difficult environment for U.S. contractors, who no longer have outstanding technological advantages to set against their high labor costs. Foreign government subsidies—notably tied aid credits—aggravate the situation. Major international contracts often turn on financing packages. Many foreign governments participate in assembling these packages; by and large, the U.S. Government does not. For the E&C industry, the competitive future resembles that for the Nation's smokestack manufacturing industries more than that for most other traded services.

1. Since the 1970s, *U.S. E&C firms have been losing ground steadily in international markets; they will probably continue to suffer from gradually declining competitiveness.*

During the Middle East construction boom of the 1970s, U.S. firms did well, but nonetheless saw their share of international projects fall. Other countries took growing shares, and continue to do so. Third World debt means fewer of the large and complex projects for which American companies have had competitive advantages. Growing technical capabilities in the Third World mean fewer jobs for outsiders. E&C firms with headquarters in the LDCs and NICs as well as other industrial nations offer stiffer competition for projects that do come onto the international market. As a result, U.S. market share has declined faster in the 1980s. Indeed, foreign firms have begun to make startling inroads into the U.S. E&C market; figure 5 shows the rise in new U.S. contracts of foreign construction firms—a rise that has taken place during a period when the value of new construction in the United States has declined somewhat.

2. As in many manufacturing industries where U.S. competitiveness has slipped, the reasons begin with economic growth elsewhere, coupled with improvements in overseas technology and managerial ability. That is not to say the U.S. industry is problem-free; *in general, U.S. E&C firms—and construction companies more than engineering and design firms—have yet to come to grips with their shifting competitive circumstances,* Adjustments to new realities have been slow, responses more reactive than proactive; differences in attitude and outlook between managements in American

Photo *credit: Bechtel Power Corp.*

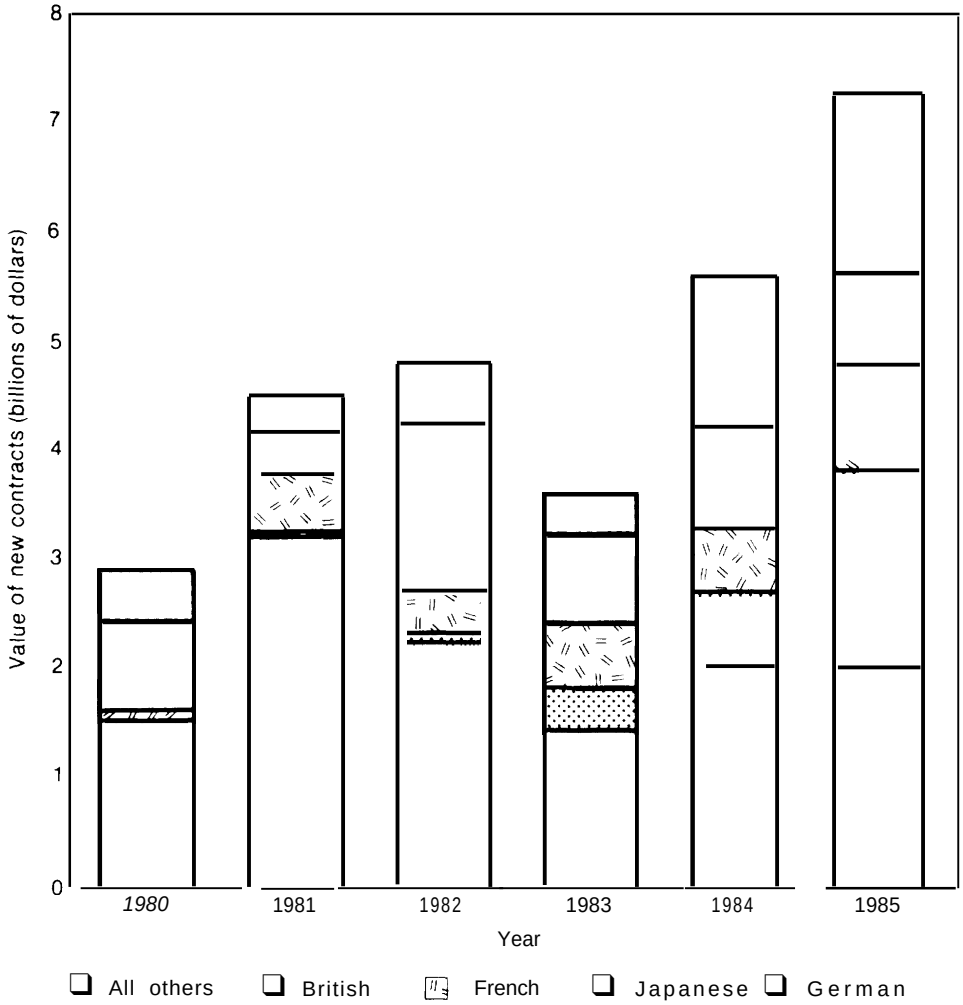
Construction on the $1 billion Ok Tedi Gold and Copper project in Papua New Guinea

E&C firms and those in banks or data processing companies have been striking.

3. Better utilization of existing technologies, and aggressive development of new technical know-how, could help American E&C firms maintain their competitive standing. The United States is no longer a leader in a surprising number of technologies relevant for large-scale construction projects. While many U.S. firms retain a deserved reputation for skills in design and in the management of complex projects—aided by the broad U.S. lead in applications of computer and communications technologies—these skills no longer suffice for competitive advantage in bidding on many international projects.

Given high labor costs (which U. S.-based contractors try to reduce by hiring foreign nationals whenever possible), and limited assistance from the U.S. Government in arranging financing, American E&C firms appear to have little choice but to move aggressively in rebuilding their industry on a base of high technology. Thus far, however, few firms have taken decisive steps

Figure 5.—Construction Contracts Won by Foreign Firms in the United States



SOURCE Engineering *NewsRecord,* various issues

in this direction. The Federal Government could help by encouraging cooperative and joint R&D to strengthen the technology base for the construction industry, as well seeking more effective methods for transferring the results of government-sponsored R&D to industry. Cost-sharing by Federal agencies would help extend time horizons for R&D projects.

Construction remains craft-based and labor-intensive, with vast scope for productivity improvement through better technology, Given the size of the domestic industry, better productivity would have far-reaching impacts within the United States as well as internationally.

4. Project financing has always been an important element in international E&C projects. Many foreign governments help arrange financing packages, not only to assist their E&C firms but to attract follow-on export business, Favored techniques include tied aid and mixed credit subsidies, which the United States normally avoids. U.S. efforts to limit subsidies have included negotiations in the Organization for Economic Cooperation and Development (OECD), along with new mechanisms intended to help Federal agencies match foreign financing in an effort to keep other governments at the bargaining table, To the extent such efforts bear fruit, as they appear to be, U.S. firms will be on a

more even competitive footing. But, while a significant step toward equalizing the terms of competition, this by itself will not be sufficient to revive U.S. competitiveness in the E&C industry.

Other policy initiatives at the Federal level can also help U.S. firms—e. g., set-aside programs for U.S.-funded projects overseas (military construction, as well as construction for embassies and consulates). But the shifts in competitiveness visible in the international E&C industry are deeply rooted in technological change and international economic currents. *Federal policies can, at best, provide support for new strategic thrusts by the U.S. industry—thrusts that have yet to take shape—* they cannot reverse the forces leading to change in international E&C markets.

Information Technology Services

Along with banking, the cluster of sectors including telecommunications, data processing (DP), information services, and computer software—the IT services—has the greatest impacts on competitive prospects of other U.S. industries (ch. 5). Cheap and reliable international communications mean that an American engineer on site in a foreign country can tap into the piping design layout for a petroleum refinery, change a hanger, and calculate the seismic response in a few minutes, One set of computer programs manages the functions of the communications hardware; other software carries out the calculations. Some applications of IT services cut costs, as when a DP service bureau handles another company's health insurance claims, Strategic applications of IT services help firms create new products and enter new markets—for instance, a chemical manufacturer may tie customers into its computer network so they can place their own orders.

1. *Of the IT services, telecommunications and computer software are most important for U.S. competitiveness in other industries.* Multinational integration depends on global communications. Computer software helps firms in all industries control costs and develop new business strategies; software tools will be particularly vital in building a high-technology base for U.S. manufacturing. Today, engineers in many industries rely on software aids for design and development of new products; software then controls the factory equipment that makes these products.

Both the telecommunications and software sectors are growing rapidly. So is information services (e.g., electronic databases)—a relatively small and specialized sector today, but one that will take on much greater importance in the future. In contrast, the DP services industry has already matured; growth has slowed, in part because many companies that once purchased DP services now take care of much of their own computing.

2. Currently, American firms are highly competitive internationally in all four IT sectors, Their positions appear generally secure over the short to medium term, particularly in DP and information services, Telecommunications and software, for differing reasons, will be a good deal more volatile, and may demand the attention of policy makers.

Value-added data communications networks (VANs–including the computer networks that link banks together, and that tie airlines and travel agents) will grow rapidly. Commercial VAN services will become important tools for businesses both domestically and internationally, particularly smaller companies that cannot afford their own networks, Larger U.S. companies will want their own VANS, but will use services supplied by independent vendors for some purposes as well. Development paths will depend in part on regulations here and overseas. *To the extent that policymakers can shape regulatory environments that will speed the expansion of VANS, ensure the availability of VAN services to small businesses as well as large, and guarantee U.S. firms access to overseas VAN markets as both suppliers and users, American businesses of all types will be in a better position to compete internationally.*

U.S.-based software firms remain undisputed leaders in world markets. Indeed, other gov-

ernments have viewed the U.S. lead in software with a good deal of concern. Nations like West Germany have shifted government support from hardware (e.g., microelectronics) to software. Developing countries like Singapore and Taiwan emphasize software in their programs for catching up technologically. And of course Japan, with its heavily publicized fifth-generation computer project, seeks software that will help its computer manufacturers penetrate world markets more deeply. Why the focus on software? First, because of the cost-cutting and strategic applications for users almost anywhere in an economy, Second, because productivity in the generation of software itself has been nearly stagnant, Raising software productivity y holds enormous promise for multiplying the productivity increments in other industries. Moreover, *U.S. competitiveness in computer hardware, and indeed in all high-technology industries, increasingly depends on software.* Today, software needs and availability often shape the design of hardware; indeed, software is often integrated into hardware (e.g., through functions embedded in semiconductor chips).

Rapid progress in automated software development could lead to shifts in international competitive standing. So could unexpected success in foreign projects such as Japan's fifth-generation effort. But the more likely outcomes of future competition will be gradual slippage in the U.S. position, particularly as foreign software firms move away from custom programming. Specially tailored software is expensive, and no longer a good solution to many customer needs. Cost pressures will drive countries like Japan toward the standardized applications packages pioneered by American suppliers. As foreign software companies begin producing standardized products, they will be able to compete more effectively with American suppliers. The Japanese, in particular, will become more competitive, if only because their rapid progress in hardware will force them to do better in software. *A* narrowing *gap* between *U.S. and foreign industries could prefigure a challenge in computer software not unlike past challenges in microelectronics*. Furthermore, better software in Japan—and in particular, programs that can deal efficiently with the complex character set of the Japanese language—will lead to major productivity increases *throughout* Japan's economy. Office automation is only the most obvious example.

3. Neither the fragmentation of responsibility for U.S. international telecommunications policy, nor foreign government policies—including the much-discussed possibility of restrictions on transborder data flows (TBDFs)—have, as yet, had major competitive impacts on U.S. businesses operating internationally, But with American firms of all kinds increasingly dependent on telecommunications, *Federal agencies with both domestic and international responsibilities will have to make impacts on competitiveness a normal and routine, rather than extraordinary, element in the policy process*.

As more American companies do business in more parts of the world, negative impacts of NTBs affecting telecommunications and related IT services become a more serious prospect. TBDF restrictions, onerous rate structures within particular countries, discriminatory access to network facilities—any of these could harm U.S. competitiveness in a broad range of industries. That the impacts have not been major ones in the past does not mean they could not become so in the future.

4. The next generation of telecommunications technologies—Integrated Services Digital Networks, or ISDN—will provide end-to-end digital communications for voice, data, and in some cases video signals. New services—e. g., computer networks—will be cheaper; eventually, any home or office that now has a telephone should be able to tap an information utility with a very broad array of available services. ISDN as an information infrastructure could parallel the Interstate Highway System in its impacts on the Nation's economy,

The capital costs of ISDN, however, will be enormous—hundreds of billions of dollars by the time, well into the next century, when international ISDN coverage becomes widespread. Technical standards will influence the costs,

as well as the outcomes of competition involving equipment manufacturers, service suppliers, and users. The stakes are very *high*. Vast expenditures, and commensurate rewards to successful suppliers of equipment and services, will generate a great deal of conflict, both within and among the nations that design and build ISDN networks.

With different firms and different governments beginning to implement ISDN, the U.S. Government will face continuing decisions in international forums concerning technical standards, as well as questions of domestic regulatory policy. Given the tight control exercised by PTTs (post, telegraph, and telephone authorities, generally functioning as government monopolies) in many countries, negotiations over issues such as TBDFs and the international implementation of ISDN will probably go on for years. The costs of incompatibility in ISDN standards could be high, while the interests of equipment suppliers and user groups may differ substantially. As the U.S. position evolves, Congress may wish to review procedures for coordination among the many Federal agencies involved, and the specific preparations for standards-setting and related negotiations internationally. Regulatory *decisions in telecommunications, as in banking, have seldom reflected considerations of international competitiveness; in the future, they will need to do so.*

Before the AT&T breakup, many of these matters could be left to technical experts; today, with numerous companies competing to find an edge in the marketplace, matters of commonality, harmonization among systems, and standards demand high-level policy attention. The next several years could well be critical, with discussions planned within the International Telecommunication Union (ITU) that may have substantial implications for trade in telecommunications services as well as equipment. Congress, at several junctures, may wish to review efforts to develop and coordinate the U.S. position at these meetings and in GATT among the agencies involved (which include the Department of State, the Federal Communications Commission, USTR, and others).

5. The United States might learn a good deal from close observation of foreign government policies affecting the IT services, Both France's Teletel/Minitel system (which has put simple computer terminals in more than 2½ million homes and offices), and Japan's very ambitious plans for ISDN, hold considerable promise for stimulating development of new business activities—among both service suppliers and equipment manufacturers. Even if the U.S. Government continues to leave developments such as videotex totally to the private sector, insight into policies and outcomes overseas could help inform the regulatory decisions that will always be necessary here.

Technical Licensing

For years, the United States has been a source of technology for the rest of the world. Many American companies, mostly manufacturers, license not only patents, but knowledge and expertise (ch. 6), By value, most of these licenses go to affiliates—foreign joint ventures as well as the overseas divisions of U.S. multinationals —where control of proprietary know-how is easier than with an independent foreign firm.

In years past, many U.S. companies took their emerging Japanese rivals too lightly. Few would do so today; there is little evidence that American companies license their technology too cheaply—that is, that they continue to underestimate the risks of future competition from their licensees, But just because firms look out for their own interests does not mean they look out for their competitors' interests (or their suppliers' or customers' interests, or the national interest).

Today, the United States can also learn from the rest of the world. With overseas technology often as good as American, many more U.S. companies could benefit from seeking out and licensing foreign technologies. A more balanced two-way flow would be a positive sign for future U.S. competitiveness. Indeed, growth in U.S. licensing revenues has slowed since the beginning of the 1980s, This is one of many symptoms indicating that the vast base of technology underlying the Nation's commercial

industries—particularly sectors well removed from defense needs—no longer adequately supports an economy as large and diverse as that of the United States. Coupled with indications of declining productivity in U.S. R&D, OTA's analysis suggests a real need for overhauling the Nation's technology policy.

1. U.S. companies license their technical knowledge primarily when other opportunities for exploiting it–exporting goods from the United States, direct investment in overseas manufacturing plants—have been cut off. Today, foreign governments use policies such as import barriers, investment incentives, and performance requirements more effectively than in the past to encourage transfers of technology to their own firms. *American companies have increasingly been forced into licensing agreements and joint ventures as substitutes for exporting or wholly owned foreign plants.*

U.S.-based multinational corporations (MNCs) have responded, in part, with integrated worldwide strategies in which licensing becomes an option to be bargained over from the beginning. The multinational may, for example, try to lock foreign partners into its proprietary technology through licensing, so that it will have at least a piece of the market, even though it cannot sell its exports. Or it may seek arrangements in which licensees will depend on purchases of components from the United States (e.g., advanced microprocessor chips). This is one of many examples of shifts in the international business strategies of U.S.-based firms where a sound analytical grasp by Federal agencies would aid in the development of negotiating positions during the Uruguay Round.

2. Given shrinkage or loss in the technological leads that so many American industries enjoyed a decade or two ago, some U.S.-based companies have become notably more aggressive in locating and acquiring foreign know-how through exchanges, joint ventures, or outright licensing agreements. Many others have yet to take such steps. *Federal policies—e.g., evaluation of foreign technical capability, critical reviews [as well as translations) of foreign technical literature, support for personnel exchanges—that encouraged inflows of foreign technology could help support the long-term competitiveness of many U.S. industries. So* could continued efforts by the Federal Government to ensure that the overseas affiliates of American firms have the right to participate in government-supported R&D programs, and equitable access to results.

3. Rough parity among major industrialized nations has become the norm in many industries and many fields of technology. Increased inward licensing paints much the same picture as other indicators: U.S. technology is no longer broadly superior to foreign know-how. Indeed, American firms have fallen behind in a surprising variety of cases (as ch. 4 outlines for the E&C industry). Attributable as much to improved technical abilities in other parts of the world as to slow-down in the United States, this relative shift is most evident in industries well-removed from military needs and defense funding—in steel rather than computers, autos not aerospace. Many of the indicators, indeed, point to priorities for the development of commercial (i.e., non-military) technologies that are markedly higher in countries like Japan and West Germany than in the United States; table 1, for example, shows that both Japanese and German companies spend relatively more on R&D than American firms.

Given the breadth of the technology base that supports commercial industries, the services as well as manufacturing, *Congress may wish to consider major changes in U.S. technology*

Table 1.—Business-Funded R&D as a Percentage of Gross Domestic Product

	1972	1981	1983	1985	1986a
United States . .	0.99 °/0	1.22°/0	1.32°/0	1.39°/0	1.42°/0
Japan	1.15	1.73	1.99	2.09	2.14
Federal Republic of Germany . . .	1.08	1.46	1.56	1.64	1,69

[a]Estimated

SOURCES' 1972: *Science and Technology Indicators Basic Statistical Series — Volume B Gross National Expenditure on R&D GERD 79697982* (Paris Organ! zation for Economic Cooperation and Development, 1985), table 16, 1981-1988: "FRG Institute Compares German, U S , Japan Research Expend itures, " *Europe Report—Science and Technology,* Joint Publications Research Service JPRS-EST-86-033 Nov 6, 1966. pp 25, 28, 31 Translated from *Technologie Nachrichten*, May 15 1986 Original source, Battelle Institute, Frankfort

policy. Such a reassessment might begin with the recent turn toward Federal support for basic research almost exclusively. In the past, government agencies provided a mixture of support for basic and applied research. But the path from basic research to the marketplace is long and tortuous; Federal support, if restricted to basic work (and particularly to research in science rather than engineering), may not aid U.S. competitiveness for many years, perhaps decades. Policy initiatives such as support for generic technologies (those that can help all firms in an industry), and better mechanisms for diffusing commercial technologies to the vast majority of American companies that are not technologically self-sufficient, could make a significant difference. The costs would be small relative to total Federal R&D expenditures.

4. Although Japan has licensed U.S. technologies extensively in the past, and NICs like South Korea are currently seeking U.S. know-how as part of their development strategies, *OTA has found little evidence that licensing by American firms has, in recent years, been counterproductive from the perspective of individual firms—i.e., that license fees have been too low*. Nor does it appear that U.S. companies have, with rare exceptions, licensed at any price technologies critical for their own longer term competitiveness. But firms look out for their own interests, not those of their competitors; moreover, in earlier years, many American companies plainly underestimated the capabilities of Japanese manufacturers.

Finally, when foreign governments combine restrictions on imports and investment to pressure U.S.-based MNCs into licenses either at arms-length or with joint venture partners, they may be able to help local companies buy technology more cheaply than would otherwise be possible. Regulating technology outflows holds scant promise as a U.S. policy alternative. It is corporations, not governments, that develop and control proprietary technologies. But government policies aimed at helping American companies learn from foreign know-how could aid in bringing inflows and outflows into better balance.

Domestic and Labor Market Implications

Despite the many differences among the services examined in this assessment, international competitiveness in all of them depends heavily on human capital. Production of knowledge-based services (and goods) requires skills and abilities, know-how and judgment, that will be supplemented but not replaced by emerging computer and telecommunications technologies (ch. 8).

Automation and productivity improvement cut into job opportunities in industries that utilize computer and telecommunications systems intensively. Nonetheless, to the extent that firms in industries ranging from shoes to chemicals, insurance to modular housing, can apply such tools effectively, “dematuration” processes will help preserve job opportunities for Americans over the medium term and beyond. Both domestic employment in better paying, more highly skilled jobs, and the position of U.S. firms in world markets, depend on the maintenance of a comparative advantage in the production of knowledge-based goods and services.

1. To the extent that the U.S. labor force remains a source of well-educated employees with skills needed by service firms, the Nation is likely to remain internationally competitive in most of the knowledge-based services. This, in turn, will help U.S. manufacturing industries maintain their competitiveness. It will also help support a tertiary service sector that can continue to create jobs for Americans who are badly educated or lack specialized skills—jobs that will, however, pay little and provide no more than limited opportunities for advancement,

To maintain their international competitiveness, American firms in many of the service industries, as in much of manufacturing, must be able to respond quickly and effectively to changing market needs (in terms of output level or product mix), new technological opportuni-

ties, the twists and turns of foreign government policies. Flexibility can come from new technologies, mostly computer-based. But it ultimately rests on a work force with broad and deep skills. Both *new technologies and a more highly skilled labor force will be needed if knowledge-based service industries are to adapt successfully to new competitive realities,*

2. In most of the service industries, exports and imports remain small compared to domestic consumption (or sales through foreign affiliates). *Employment levels in the services, therefore, do not depend very directly on trade.* Nonetheless, indirect effects can be important —e. g., employment created in service firms that sell to exporters (of goods or services). There are no good estimates for the value of services embodied in goods exports, or the numbers of jobs created. But it is possible to state that such jobs will, on the average, be relatively highly skilled and well paid—particularly for high-technology manufactured products, with their heavy inputs of knowledge (regardless of whether manufacturers produce these knowledge inputs internally or purchase them from service companies). Likewise, most of the direct employment benefits of foreign investment in the services accrue to the host country; thus investments in the United States by foreign service firms–e.g., Japanese or French banks with offices in New York or San Francisco—create jobs for Americans.

3. In searching for low costs and flexibility, American firms are increasingly turning to temporary and/or part-time workers. By supplementing a core staff with contingent employees, companies can adjust quickly to shifts in demand. (Temporary help services has been one of the fastest growing U.S. industries.) Part-time employees help firms with labor requirements that vary predictably to minimize costs—e.g., banks that need more tellers on Mondays and Fridays, or retail stores open evenings and weekends.

The steady rise in people taking part-time jobs involuntarily—because that is the only work they can get—suggests that underemployment is joining unemployment as a persistent U.S. economic problem. But greater numbers of Americans are also working voluntarily in part-time or temporary positions. This reflects, among other things, a labor force with increasing levels of education and skill and a greater number of largely autonomous people who can pick and choose their work (graphic artists, computer programmers, auto mechanics). With Americans starting as many as a million new businesses each year (including those that are unincorporated), self-employment and new small-business startups have become more popular choices, So has work in the underground economy.

4. As the rise in involuntary part-time work suggests, together with the growing numbers of jobs that require credentials such as a college degree for entry, stratification in terms of income and career prospects will continue to increase within the U.S. labor market. Restructuring and applications of new technologies in many service firms have knocked the rungs out of internal promotion ladders. No longer can high school graduates enter an insurance company or a chain retailer and hope to move steadily upward in pay and responsibility. At least some college will be required for entry into many positions with prospects for upward mobility. Despite the rise of higher education over the last **25** years, then, *many Americans will find themselves stuck in low-paying service jobs with limited chances for advancement.* There seems little prospect that low-skilled, entry-level service jobs will ever lead to the long-term career earnings patterns characteristic of blue-collar manufacturing employment in the earlier postwar period.

5. Many recent immigrants into the United States, especially those entering illegally, take low-paying jobs in the tertiary services. But immigrants also cluster in skilled occupations such as nursing and engineering (service functions even if in manufacturing companies). *U.S. industry has come to depend on a supply of foreign-born employees—notably, engineers and scientists who choose to stay after com-*

pleting their education at an American university. To some extent, foreign nationals with technical training—who generally cannot qualify for security clearances—help balance the flow of U.S. citizens into defense-related industries.

Capable, well-trained people—regardless of field—will always be in demand. To the extent that immigrants add to the pool, they help U.S. industries compete.

6. Will the U.S. economy be able to draw on the human capital–the knowledge and skills–needed to create good jobs and support high living standards in the future? New technologies and new ways of doing business demand high-level skills—not only reasoning, problem-solving, and creativity, but interpersonal and social skills. And learning itself is a skill. In the emerging knowledge-based economy, *people will need to learn to work effectively in fluid and ambiguous environments, to accept responsibility individually and in groups—in many respects to behave more like managers even though they may not have jobs that are explicitly managerial.*

Higher-order problem-solving, good judgment, learning from experience–schools often pay lip service to these skills, but seldom try systematically to develop them. OTA's analysis suggests that preparation for work in the 21st century may demand a fundamental rethinking of the Nation's education and training system, Despite the attention focused on education over the past several years, there is little indication that such a reexamination has begun.

FEDERAL POLICIES

In the services even more than in manufacturing, government policy makers have seldom paid much attention to international competitiveness (ch. 10). This is changing, slowly. Congress has called for better coordination among the dozens of Federal agencies whose policies and regulations affect the services, and the Administration has begun to respond. Antitrust enforcement reflects the realities of international competition more strongly today than 10 years ago. U.S. persistence in GATT demonstrates that the highest levels of government have endorsed the goal of liberalizing trade in services,

Still, the United States has a long way to go to put its own house in order. Many of the impacts of regulatory and supervisory policies on international competitiveness occur indirectly; service industries ranging from insurance to air travel will remain more heavily regulated than typical manufacturing industries. Given the deregulatory fervor of the past dozen years, the policy shifts affecting competitiveness in sectors like banking or telecommunications have emerged from confused and confusing debates (such as that over non-bank banks, or deregulation/re-regulation of the telephone system). The complexity of technology and business practices in such industries makes it difficult for policy makers to grasp the issues; indeed, deregulation, falling back on the magic of the marketplace, has sometimes been little more than an admission of this failure. But withdrawal as well as intervention has competitive consequences, and good policy choices demand insight into these consequences. American business, with some exceptions, has adapted relatively quickly to immersion in a world economy rather than a national economy. American government, which remains primarily attuned to domestic needs and domestic interests, has not.

Other governments face the same problems: linking domestic policies and foreign economic policies; linking the problems and needs of service industries and manufacturing industries. Some have responded better than the U.S. Government, some worse, The more successful governments—and particularly those that have learned to shape market outcomes with some effectiveness—pose yet another test for the United States. When other countries take this tack, the stakes go up in trade negotiations. Yet the lack of planning capability and institutional

Photo credit: *Walt Disney Productions*

U.S. travel and tourism exports came to $13 billion in 1986.

memory in Federal agencies mean that sometimes U.S. policy makers may not even realize what is at issue.

Tables 2 and 3 summarize the policy options discussed in chapter 10, with table 2 providing an abbreviated guide to the 33 options and table 3 treating them in more detail. (Both appear in chapter 10 as well. Table 2 is the same as table 55, while table 3 condenses material found in tables 56, 57, 59, 60, and 61.) While many of the options deal with the specifics of particular government programs, the overall focus is on the capability and effectiveness of the policymaking system as a whole.

The first group of options (l-11) are concerned with U.S. trade policy. The subjects range from negotiating approach and objectives during the Uruguay Round, including the resource needs of the agencies involved, to the United States and Foreign Commercial Service (which looks understaffed alongside export promotion efforts by competing nations). In this group of policy options, OTA stresses the need to adequately support the Uruguay Round negotiations, which promise to be more involved and complex than previous MTNs, and beyond this to build better analytical capability into the structure of U.S. policymaking. Deeper engagement in world trade brings greater needs for coordination and planning among agencies, for clear thinking about U.S. interests and U.S. negotiating objectives.

The analysis underlying the next set of options (12-17) draws on the banking and telecommunications industries to illustrate the need for linking domestic policies—particularly regulatory decisions—with international competitiveness. Many agency policies affect the competitiveness of U.S. firms, but the system contains few mechanisms for taking account of potential impacts. Specific options here range from new Industry Sector Advisory Committees (for providing input to U.S. trade negotiators) to an office on banking competitiveness in the Treasury Department (or in another Federal agency with responsibilities for financial services).

OTA's analysis of competitiveness in the services, like past analyses of manufacturing, shows that international competitiveness has deep domestic roots, and that domestic policies—for example, dealing with education and training—have a great deal of influence over competitive outcomes. The human resources policy options (18-24) focus on adult education and training—covering questions such as educational technologies that might help build a more flexible and better-skilled work force. OTA also stresses the need to seek answers to questions such as: Will tinkering with the education and training system do the trick? Or must the United States seek fundamental changes in its educational practices to maintain competitiveness in high-value-added services and goods during the next century?

When it comes to technology development, policy choices spread well beyond the service

Table 2.—Summary Guide to Policy Options

Issue Area	Option	Relevant service sector
1. The Services and U.S. Trade Policy		
A. NEGOTIATING OBJECTIVES		
—Congressional guidance	1	all
B. COORDINATION OF SERVICES POLICY		
—Oversight on coordination of trade negotiations	2	all
C. TRADE ANALYSIS AND DATA		
—Long-term analysis for trade policy and planning	3	all
–Oversight on collection of services trade data (also see Option 12)	4	all
—Improving the data on trade in services and on technical licensing	5	all; licensing
D. SUPPORT FOR THE NEGOTIATIONS PROCESS		
—Staff and budget for USTR and other agencies.	6	all
—Service sector advisory committees (also see Option 16) ... ,	7	all
—Continuing evaluation of U.S. and foreign regulations that act as non-tariff barriers	8	all
E. OTHER TRADE-RELATED ISSUES		
—Overseas promotion of exports	9	primarily E&C
—Tied aid and mixed credits	10	primarily E&C
—Trade and Development Program (TDP) ... ,	11	primarily E&C
II. ***Linkages Between Domestic Policies and International Competitiveness***		
A. EXAMPLES FROM BANKING AND FINANCIAL SERVICES		
—Data on international trade in banking	12	banking
—Office on international impacts of banking policies	13	banking
—International coordination of regulations	14	banking
B. EXAMPLES FROM TELECOMMUNICATIONS		
—Negotiating objectives	15	telecommunications
—Advisory committee on telecommunications negotiations	16	telecommunications
—Institutional mechanisms for addressing impacts of domestic policies on competitiveness	17	telecommunications
III. ***Human Resources***		
A. EVALUATION		
—Fundamental reexamination of human resources policies as they affect competitiveness	18	all
B. ADULT EDUCATION AND TRAINING		
—Demonstration projects for training/retraining of the active work force	19	all
—Increasing the national commitment to education and training of active workers	20	all
—Postsecondary vocational/technical curricula	21	all
C. INSTRUCTIONAL TECHNOLOGY		
—Inventory of federally developed training materials	22	potentially all
—Transfer of federally developed training methods, procedures, and course materials	23	potentially all
—Funding for research, development, evaluation, and dissemination of instructional technologies	24	all
IV. Technology Development		
A. R&D IN THE SERVICES		
—Improving Federal Government data	25	**all**
B. THE U.S. TECHNOLOGY BASE		
—Federal support for commercial R&D .,	26	**all;** E&C
—Technology diffusion to industry ,	27	all
—Implementation of Japanese Technical Literature Act.	28	all
—International exchanges of technical personnel	29	all
—Equitable access to foreign technology	30	all
—Analysis of impacts of defense-related R&D on U.S. competitiveness	31	all
C. TECHNICAL STANDARDS		
—Federal testing and demonstration facility for ISDN	32	information and telecommunications; indirectly all
—Preparation for upcoming meetings of the International Telecommunication Union	33	information and telecommunications; indirectly all

SOURCE Office of Technology Assessment, 1987

Table 3.—Issues and Options for Congressional Consideration

This table (which condenses material from tables 56.57, 59, 60, and 61 in ch. 10) presents the 33 policy options in self. contained form Ch. 10 discusses them in detail

Issue	Options for Congress	Comments
ISSUE AREA i—THE SERVICES AND U.S. TRADE POLICY		
***A.** Negotiating Objectives*		
While negotiators need flexibility, close continuing contact with Congress IS essential if the Administation is to secure a trade agreement acceptable to the legislativewe branch	OPTION 1: While the Uruguay Round is in its early stages, Congress could provide specific guidance to the Administration on the outcomes it views as most critical to U S interests This could take forms includlng: • informal congressional consultations with USTR; • requiring formal consultation and reporting at several junctures before the Administration seeks congressional approval of new GATT agreements; • legislative statements of U.S. negotiating objectives, possibly including objectives for specific service sectors. This could involve amending the relevant portions of the Trade Act of 1974 (e.g., Sec. 104A, added in 1984 to define broad goals dealing with services trade, foreign direct Investment, and trade in high-technology goods).	The new GATT round raises fundamental questions concerning the U S role in the world trading system—matters going far beyond possible GATT coverage of the services: • I n what ways would a stronger GATT serve U.S. interests? • Will U.S. Initiatives in services trade and other new Issues—and in agricultural trade—serve to strengthen GATT as an institution? Will some of them and not others? • Other nations will inevitably seek concessions in exchange for agreements that U.S. policy makers view as important. What sorts of trade-offs IS the United States likely to face as we move into the Uruguay Round? • How will U.S. negotiators assign relative priorities to goods and to services when conflicts between the two arise during the discussions?
B.** Coordination **of Services Policy		
Developing trade policies for services will require effective coordination among more than 30 Federal agencies (including numerous regulatory bodies) with responsibilities for services	OPTION 2: Also at an early point during the Uruguay Round, Congress could conduct oversight (and provide guidance and direction where needed) on executive branch coordination of services trade policy, under Title Ill of Public Law 98-573 In particular, Congress might use the oversight process to determine whether coordination is adequate for ensuring consistent U.S. positions in GATT and the other international forums where sector-specific and specialized issues (e.g., Intellectual property protection) will be discussed.	Title III of Public Law 98-573 gave USTR responsibility for developing and coordinating services trade policy, using the interagency Trade Policy Committee Negotiations affecting trade in services may take place in other forums as supplements to or in parallel with GATT. Examples include OECD, the World Intellectual Property Organization, and the International Telecommunication Union
***C. Trade Analysis** and Data*		
Better analytical support would make for better U S trade policy Long-term policy planning is a particular need	OPTION 3: Establish a new office for trade policy analysis, to provide continuing analytical support and institutional memory for executive branch decisionmaking. The office could focus on support for day-to-day decisions, on longer term policy development, or both.	The primary reason for creating a new trade policy analysis unit, rather than simply providing more resources to an existing office, would be to place the new group close to policymakers —and to staff and structure it accordingly
The current database on trade in services is seriously deficient	OPTION 4: Conduct oversight on implementation Of the International Investment and Trade in Services Survey Act (as amended in 1984) to determine whether some of the discretionary provisions for data collection should be made mandatory.	In Sec. 306 of Public Law 98-573, Congress amended prior law to give clear authorization to the President to collect data on trade in services However, Congress left collection of services data discretionary
Many of the needed Improvements in services data would entail changes in procedures of the Bureau of Economic Analysis (BEA), the Commerce Department unit that compiles trade statistics The Administration has failed to approve some BEA proposals Without a congressional directive, delays may continue	OPTION 5: Direct the Commerce Department to take specific action to Improve data on trade in services. Possible steps include: • surveying service transactions between unaffiliated firms (by proceeding with the BE-20 survey or a modified version); • expanding the Census of Service Industries, • altering BEA procedures for presenting royalties and license fee data to distinguish technology from other categories of Intangible property, and to provide data on numbers of license agreements by year, and on receipts and payments on new license agreements in a given year	OTA discusses further steps for Improving the database on services trade in its special report, *Trade in Services Exports and Foreign Revenues* Also see Option 12 on financial services

Table 3.—issues and Options for Congressional Consideration —(Continued)

Issue	Options for Congress	Comments
D. Support for the Negotiations Process		
Despite the growing number of issues on the Nation's trade agenda, budget and staff resources for negotiations remain modest.	OPTION 6: Expand USTR's budget and staff to meet not only the heavy continuing work load expected over the course of the Uruguay Round, but also to carry on planning and preparations for subsequent negotiations, including those in other international forums.	As part of this process, Congress could direct the Administration to compile and annually update a statement listing the contributions of all Federal agencies to U S. trade negotiations.
If discussions on services trade move beyond the umbrella stage to sector-specific topics—and for such talks elsewhere — U.S negotiators will need more input from service industries and their employees, and from users of services	OPTION 7: Direct the Administration to establish several more Industry Sector Advisory Committees (I SACS) to speak for particular service Industries, and several additional labor subcommittees to speak for their employees, To prepare for sector-specific talks—indeed, to help determine whether these would be desirable from the U.S. point of view—Congress could direct the Administration to establish and consult with the new advisory groups at an early date.	The trade advisory committee system authorized by Sec. 135 of the Trade Act of 1974 provides a mechanism for private sector input into trade negotiations. While an overall Services Policy Advisory Com. mittee exists, only one ISAC (or two, counting that for wholesaling and retailing) represents the services at the sectoral level, compared with 14 for goods (See Opt Ion 16 for discussion of telecommunications)
Regulatory policies lie behind many of the barriers to services trade and investment, Including regulations that serve Important public purposes. Progress in reducing barriers will depend on willingness by countries to acknowledge and identify regulations that unnecessarily discriminate against foreign firms.	OPTION 8: Direct USTR (in cooperation with other agencies) to give high priority to evaluating both U.S. and foreign regulations that act, intentionally or incidentally, as non-tariff barriers to trade and investment in the services By taking the initiative, the United States could encourage other major trading nations to examine their own regulatory barriers.	USTR reports annually to Congress on foreign trade barriers The agency made a start on Identifying U S regulations affecting trade in services when it prepared the U.S. national study on services, submitted to GATT in 1983 To reach agreements on reducing barriers to services trade, nations will first have to decide what topics are appropriate for discussion.
E. Other Trade-Related Issues		
Compared to many of its trading partners and competitors, the United States devotes only modest resources to export promotion abroad	OPTION 9: Increase support for the overseas activities of the United States and Foreign Commercial Service (US&FCS), which is responsible for most of the overseas export promotion undertaken by the Federal Government, Raising the number of US&FCS officers overseas from current levels—about 200—to a complement of 300 or more would aid U.S. exporting in general Congress could also direct the Service to provide training for its employees in the special needs and problems of the service industries.	Japan has about 5,000 overseas commercial officers, the United Kingdom and France each have 400 or more
For years, the United States has sought to tighten a loophole in OECD guidelines on export credits that permits tied aid subsidies. In 1986, Congress authorized a tied-aid war chest as part of the Export-Import Bank Act Amendments (Public Law 99-472) Substantially tighter OECD guidelines followed in 1987	OPTION 10: Since other governments can always find ways to subsidize exports that they judge Important for national interests, Congress could make plain U S resolve to keep such practices under control by continuing the authorization for the tied-aid war chest—and by funding It to match foreign subsidies, if this seems needed to get other OECD members to hold to the new agreement	
The Trade and Development Program (TDP) finances feasibility studies and planning services by U.S. firms for projects in LDCs Some of these studies lead to further work for U S firms, or to exports of goods	OPTION 11 Increase TDP support from its current level of about $20 million annually —much smaller than similar programs in several other nations. Congress could also direct TDP to raise the number of feasibility studies conducted by U.S. firms on a reimbursable or cost-sharing basis	TDP has particular relevance for the E&C industry.

Table 3. —Issues and Options for Congressional Consideration—(Continued)

Issue	Options for Congress	Comments
ISSUE AREA II–LINKAGES BETWEEN DOMESTIC POLICIES AND INTERNATIONAL COMPETITIVENESS		
A. Examples from Banking and Financial Services		
Current data collection procedures fall to provide a clear picture of banking exports and imports	OPTION 12 Direct the Commerce Department's Bureau of Economic Analysis to improve its database on international banking and financial services, in consultation with the Federal Financial institutions Examination Council, and its member agencies (e g , the Federal Reserve Board)	
Decisions made by the many Federal and State agencies that supervise and regulate banking can affect International competitiveness, creating a need to build cons! deration of these impacts into policymaking processes	OPTION 13: Direct the Administration to provide an explicit mandate for an office of International competitiveness in banking to serve as a focal point for such issues, in particular the International ramifications of domestic policies	Congress could direct the Administration to establish a new group, or to expand Treasury's existing Office of International Banking and Port follow Investment
Domestic authorities, here and in other countries, have been hard pressed to keep up with rapid changes in international banking and financial services. Greater international coordination of bank supervision and regulation may be needed, along with an expansion to cover securities markets	OPTION 14: Use oversight and reporting requirements to begin evaluating alternatives for greater International coordination of banking policies One possibility would be to direct U S. agencies that serve on the Basel Committee to explore ways of expanding the Committee's present activities	Congress could also direct Federal agencies to examine and report on the desirability of creating a new international body for addressing issues of International coordination and harmonization of regulatory and supervisory policies.
B. Examples from Telecommunications		
Restrictions on trade in both telecommunications equipment and services have hindered or halted the efforts of U S. firms seeking to enter foreign markets	OPTION 15: Congress could establish formal U.S. negotiating objectives for GATT and other forums dealing with telecommunications services and equipment	Examples of possible objectives include: that U.S. firms be allowed to compete on an equal basis with host-country firms where foreign governments permit competition in telecommunications services, that, as users of foreign telecommunications services, U S -based firms not be subject to discriminatory terms, rates, and conditions
To prepare for sector-s specific negotiations on telecommunications. policymakers will need input from the fulll range of stakeholders	OPTION 16 Direct USTR and Commerce (in cooperation with other Federal agencies involved in telecommunications policy) to establish an Industry Sector Advisory Committee on telecommunications The ISAC should include representation for users of telecommunications services and employees of telecommunications firms, as well as service providers and equipment manufacturers	Because the Interests of equipment producers, suppliers of services. and users often diverge, it might be desirable to create three subcommittees reporting to a telecommunications ISAC
Because telecommunications IS a vital portion of the infrastructure for the world economy, government policies have competitive Impacts not only for equipment manufacturers and service providers, but also for users (including many U S -based firms)	OPTION 17" Direct all Federal agencies with responsibilities for telecommunications to take into account in their regulatory and other decisions the Interests of U S. firms which are users of international telecommunications services, as well as suppliers of equipment and services. If Congress restructures the Nation's regulatory apparatus (e.g., by returning more authority to the FCC), it could take that opportunity to provide such directions	It will be up to Congress, in the end, to redefine the roles of Federal agencies in telecommunications policy Whatever the choices, it will be critical that the new structure give questions of International competitiveness high priority Congress, for example, might give particular attention to the prospective role of the FCC. as an Independent agency, in dealing with foreign governments and International bodies concerned with telecommunications
ISSUE AREA III–HUMAN RESOURCES		
A. Evaluation		
Despite numerous commissions and task force reports, no consensus has emerged on adapting education. training, and other human resources policies to the new circumstances resulting from U.S. immersion in the international economy	OPTION 18: Call for a fundamental reexamination of human resources policies, and an evaluation of specific steps to enhance the ability 0f Americans to adjust to shifts in labor market and workplace conditions resulting from International competition.	Congress could charter an Independent council or Institute to report and make specific policy recommendations. Or it could ensure that human capital issues get a prominent place in the mandate of any council or other body established by Congress to examine and make policy recommendations on International competitiveness

Table 3.—issues and Options for Congressional Consideration —(Continued)

Issue	Options for Congress	Comments
B. Adult Education and Training		
A work force with good skills is essential for maintaining U.S. competitiveness While some companies provide broad-based education and training for their employees, others do little or nothing.	OPTION 19: Direct the Administration to undertake pilot and demonstration projects, in cooperation with business and industry, on new approaches to training and retraining of active workers. Involvement by organized labor would also be desirable. Such programs would not require new authorization.	In its 1986 amendments to JTPA (Public Law 99-496), Congress authorized the Secretary of Labor to fund pilot projects for training, while the Carl D. Perkins Vocational Education Act of 1984 (Public Law 98-524) provides for a special State grant program for adult education and retraining.
Demonstration projects alone will not lead to major increases in training for employed adults	OPTION 20: Consider alternatives to increase the national commitment for training and retraining of the adult work force, Including incentives for employer-provided education and training and new sources of funding.	Proposed alternative funding mechanisms have included tax credits for firms that provide certain kinds of training, and a payroll-based tax to fund retraining services for workers,
General vocational curricula that would provide a foundation for continuing (restraining could help people in the knowledge-based Industries adapt to future workplace changes,	OPTION 21: Direct the Department of Education, in cooperation with the Department of Labor, to fund demonstration projects for broad-based vocational curricula, focusing on generic skill development for the knowledge-based services. Grants could be made available to both public vocational-technical schools and proprietary (trade) schools.	Business and industry should be actively involved in any such experimental and demonstration projects. The Carl D. Perkins Vocational Education Act of 1984 provides a suitable vehicle for this option
C. Instructional Technology		
The Federal Government has developed a great deal of technology and instructional material for training, Some of this could be useful to the private sector and the schools, but only limited Information has been easily available to educators and private sector trainers,	OPTION 22: Direct the Administration to give priority to timely completion of the feasibility study for an inventory of federally funded training software called for by the Federal Technology Transfer Act of 1986. Should it seem appropriate once the feasibility study has been completed, direct the Administration to proceed with the inventory.	Congress called for the feasibility study in the Federal Technology Transfer Act (Public Law 99-502), which amended the Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 98-480).
Transfer of training technology from the government to schools and to the private sector may involve several agencies, as well as requiring modifications to course materials.	OPTION 23: Instruct Federal agencies to place more emphasis on transfer of training technology and course materials to public institutions and corporations, initially through technology transfer mechanisms as authorized in Public Law 96-480 Congress could follow with oversight to determine whether new mechanisms should be created specifically for diffusion of training technologies.	Examples of executive branch efforts to transfer training technology include a computer-assisted reading program developed by the Navy and transferred to some libraries.
Realizing the long-term potential of instructional technology will require continuing research on teaching and learning, Beyond R&D and the development of new teaching and training materials, dissemination of new methods—including computer-based training—will require ongoing Federal support.	OPTION 24: Increase funding for research, development, evaluation, and dissemination of instructional technologies—including adult education and training, One approach would be to direct the Department of Education to establish and provide partial funding for a research center concerned specifically with adult learning, and including R&D on instructional technologies,	Federal funding for such a program could be kept modest by requiring matching grants from foundations and the private sector, which stands to benefit substantially. Congress, in the Higher Education Amendments of 1986 (Public Law 99-498), called for a national program of research on adult learning—without, however, authorizing funding
ISSUE AREA IV–TECHNOLOGY DEVELOPMENT		
A. ***R&D in the Services***		
OTA finds U.S. R&D related to services to be much greater than reported in the usual Federal Government data series.	OPTION 25: Direct Federal agencies—specifically, the National Science Foundation—to develop new criteria for identifying and collecting information on R&D and technology development related to the services,	Services R&D has been underreported for reasons similar to those for the underreporting of services trade in the U.S. current account—outdated and unexamined procedures, many of which simply omit service activities.

Table 3.— Issues and Options for Congressional Consideration—(Continued)

Issue	Opt Ions for Congress	Comments
B. The U.S. Technology Base		
The services depend on much the same technology base as manufacturing Leaving aside national defense, the Federal Government provides relatively little funding for technology development	OPTION 26: Increase Federal R&D support for commercial (i e., non-defense) technologies by expanding initiatives such as NSF'S Engineering Research Centers, and ensuring continued funding for existing programs such as the Center for Building Technology at the National Bureau of Standards	
Congress has called for more emphasis on diffusion of technology to American industry through such laws as the Stevenson-Wydler Act (Public Law 96-480) The Administration, however, has only implemented parts of the legislation	OPTION 27 Alternatively or in addition to the steps in Opt Ion 26, Congress could, under the 1986 Federal Technology Transfer Act (the 1986 amendments to Public Law 96-480), authorize, provide funding for, and direct the Administration to offer grants for Centers for Cooperative Research For greatest effectiveness, these centers should be charged with technology diffusion as well as development.	Should Congress choose to create an Advanced Civilian Technology Agency or National Technology Foundation—as has been proposed in a number of bills introduced in recent years —cooperative technology centers would fit naturally into its role and function Technology diffusion programs could be cost-shared between the States and the Federal Government
The United States, no longer the unquestioned leader in technical knowledge, will need to do a better job of learning from foreign technology in years to come	OPTION 28 Emphasize congressional commitment to implementation of the Japanese Technical Literature Act of 1986 (Public Law 99-382) through early oversight and full funding If Congress wishes to place more emphasis on screening and evaluation, or to direct the Administration to fund translations of Interest to university-based researchers. it could direct the Commerce Department to share responsibility with agencies having more experience in technology and science—e g the National Science Foundation	
	OPTION 29 Increase support for exchanges of U.S. technical personnel with those of other nations Congress could fund fellowships that would send graduate students in engineerlng to countries like Japan, as well as considering programs that would provide partial support. in conjunction with employers, for Industrial engineers and scientists working abroad temporarily (in industry or in universities)	Sending more engineers and scientists to work temporarily abroad could help change corporate attitudes in the United States, and would give American industry more rapid access to foreign technologies as they emerge
	OPTION 30: Make equitable access to foreign technology a formal U S negotiating objective, and call for reductions in restrictions on access for U S citizens to publicly supported R&D projects in other countries	Pursuit of this objective (included in H.R. 3 as passed by the House in May 1987) would need to be consistent with U S policies on foreign access to results from government-supported R&D projects here.
Policy adjustments may be needed to capitalize on the potential of defense spending for enhancing the competitiveness of commercial Industries	OPTION 31 Investigate and evaluate policies for maximizing the positive impacts of defense-related R&D and procurement on the international competitiveness of American industries.	Analysis of the linkages between the military and civilian sides of the economy might also lead to policy changes making it easier to adapt commercial technologies to military systems
C. Technical Standards		
Before the AT&T breakup, a single company dominated the process of setting technical standards. Today, the process involves many firms in competition with one another	OPTION 32: Direct the National Bureau of Standards (in cooperation with the National Telecommunications and Information Administration) to set up an ISDN testing and demonstration laboratory to help government agencies make purchasing decisions and take advantage of emerging technical capabilities. and to help pave the way for a smooth transition to ISDN in the United States	NBS's Institute for Computer Sciences and Technology already has related work underway. An ISDN laboratory could provide independent assessments to support Federal procurement decisions, and also disseminate information to private sector users of telecommunications *services*

Table 3.—issues and Options for Congressional Consideration—(Continued)

Issue	Options for Congress	Comments
Developing U.S. positions at the ITU has become far more complex since the AT&T breakup Future ITU deliberations may well define a global framework for ISDN, with Impacts on equipment sales as well as services	OPTION 33: Congress could anticipate the possibility that incompatible standards for ISDN will be proposed both internationally and within the United States, and begin to take preparatory steps to address such issues. Specific actions might include: • oversight to review U.S. preparations and negotiating positions for upcoming ITU meetings (e.g., WATTC-88), and the Implications for U.S. positions at GATT and in other trade negotiations dealing with telecommunications; • requesting a comprehensive study to review prospective ISDN standards and implementation, with a view to laylng groundwork for future policy decisions (e. g., if it appears that U.S. telecommunications carriers might adopt dissimilar approaches that would be costly for users).	The State Department coordinates and presents U.S. positions at the ITU. The Department relies heavily on the private sector, through committees, for advice on U.S. recommendations concerned with standards

SOURCE Off Ice of Technology Assessment, 1987

industries (Options 25-3 1). Competitiveness in the services springs from a technology / science base much the same as that for manufacturing. This fact alone—which has not been widely recognized—means that strengthening the infrastructure for development and diffusion of a wide range of technologies could help both sides of the economy. Higher priorities for commercial technologies seem needed, Governments in countries like Japan pay much more attention to pre-competitive technologies that can help all firms in an industry, Indeed, Federal policies aimed at encouraging inflows of technical know-how from countries like Japan could help U.S. competitiveness.

Achieving a better balance between science and technology, and finding ways to maximize the benefits of military R&D and Federal procurement for commercial technology development would also help American companies in many industries maintain and strengthen their competitive ability. Among the services, the need for better technology is most obvious in E&C firms, but certainly not limited to them. The last two options (32 and 33) reflect the significance of technical standards for international competition. The standards set in international bodies sometimes shape competitive outcomes quite directly, Other governments frequently try to influence these decisions. ISDN standards, for example, could have far-reaching implications for future competition in both services and in sales of computer and telecommunications equipment.

Standards-setting activities provide one of many examples of issues that often become lost in the fragmented structure of U.S. policymaking, Of course, dispersal of authority has been intentionally built into the U.S. system. The immediate problem is whether the system as currently structured can respond to the new needs of the U.S. economy, These needs are plain enough, Over two decades, even less, a broad array of American industries has lost competitiveness internationally. With continued movement toward an interdependent world economic system, the pressures on U.S. industry will continue to build. Firms and industries adjust, because they must. Some companies have failed, Others have moved abroad. Many have adopted new technologies, reduced their employment levels. But will the policymaking system adjust? The stakes are high: U.S. living standards have already begun to decline.

Certainly there are signs of change in Federal agencies. Deregulation has been one response, the services initiative in GATT another.

Have the policy adjustments been fast enough? Has the system changed in the right direction? Will our rather disorderly apparatus, with many agencies sharing overlapping responsibilities, continue to prove adequate? If other nations follow the U.S. lead, deregulating more than regulating, opening more markets than they close, then the answer is probably yes. If, on the other hand, other nations rely more heavily on national industrial policies to guide development, learn to use these policy tools with some effectiveness (as the Japanese have already done), and pay only lip service to GATT discipline, the answer will probably be no, In the latter case, the U.S. system—where structural adjustment as a policy goal has never been legitimated, and trade policy remains an appendage—will be a grave handicap.

If other nations do take the route of greater government involvement in economic affairs, then the United States may have little choice but to follow. If we do not, many of our remaining advantages-for example, in the information technology services-may slowly dissipate, Other governments will continue to extract concessions from U.S. businesses, and help their own firms chip away at U.S. markets. Telecommunications services and equipment illustrate many of the problems. Trade friction has been high for years. Repeated efforts to reach agreements on subsidies and ''targeting" have come to little. Disputes will certainly continue. The European nations—where government ownership of PTTs is the rule—have embarked on extraordinary measures to promote technological development in computing and communications systems, while simultaneously trying to limit competition and protect jobs. Trade friction with Japan over telecommunications will continue as well, with the difference that Japanese policies have been more far-sighted than those in Europe–easier, given low unemployment rates, a single dominant political party, and a huge trade surplus. Meanwhile, the stakes have been going up, as the next generation of telecommunications technology—ISDN—begins to materialize. Thus far, some of the European nations, as well as Japan, have taken at least tentative steps toward deregulation, following the U.S. lead. Yet this primary difference remains: the United States has deregulated for domestic reasons; other countries have made their choices for reasons including international trade and competition. Leading exporters like West Germany and Japan have built consideration of impacts on trade and competition into their policymaking structures. They have many years of experience, often painful, in learning to use government policies to aid their country's businesses internationally. The United States has never had such a trade (or competitiveness) policy. Through most of the 1970s, at least, there seemed no need.

Over the postwar period, the United States sought, in many ways, to help other nations develop economically. By and large, these efforts have been successful. U.S. leadership helped ensure open international markets for trade and investment. Seven rounds of multilateral trade negotiations have left tariffs at low levels; although NTBs have replaced many tariffs, the world economy is more open today than ever before, Technology has diffused widely; many nations have moved steadily up the ladder of development. The United States has achieved much of what it sought over the past **40** years. Unfortunately, many American industries are having trouble competing in the world U.S. leadership created.

* * *

The following section, the last in the chapter, expands on the introductory paragraphs of this summary, and prefigures portions of the analysis in the body of the report.

EVOLVING INDUSTRIAL STRUCTURE: SERVICES AND GOODS

To some, the service economy is an information economy, symbolized by communications satellites, computerized financial transactions, pervasive electronically based media. Other images center on more personalized service products—psychotherapy, schooling, fast foods.

Looking at the U.S. economy in 1987, some observers would predict a de-industrialized future, in which too many Americans will take in each others' laundry, while U.S. manufacturing industries continue to decline internationally. Others, looking at the same picture, see a high-technology, post-industrial future—a future filled with smart machines helping produce knowledge-based services as well as the familiar tertiary and personal services, and with other smart machines revitalizing the manufacturing side of the economy.

Despite the examples of satellites or cheaper overseas air fares, most of the images have a domestic context. Few people know much about markets for Eurobonds, or the technical licensing transactions through which U.S. corporations exploit their know-how overseas. Internationally, trade in goods gets far more attention than trade in services—no surprise, given the huge U.S. deficit in goods trade.

Much the same is true in other countries. Some countries opposed inclusion of the services in the Uruguay Round negotiations because they saw nothing to be gained. Others—including NICs like Brazil and India, the leaders of the group opposing the U.S. initiative—see more clearly the importance of services for continuing economic development, but think they will lose if forced to open their markets. Some countries have been more receptive, but the LDCs and NICs in general—most with relatively small service sectors—have been slow to recognize ways in which liberalization might work in their interests.

The Services and Manufacturing: Synergies and Interdependencies

In 1986, the invisibles account—direct exports of services plus income from U.S. investments abroad—contributed 38 percent of total U.S. exports. Within the invisibles account, however, investment income (e.g., remittances from foreign affiliates of U.S. firms) outstrips exports of services (e. g., banking services provided from the United States for customers abroad). The official U.S. balance of payments lists direct exports of services at some $49 billion in 1986, compared with $91 billion for investment income, and $222 billion for exports of goods.

OTA's own estimates, summarized in chapter 2, show that the official statistics seriously understate both imports and exports of services, While OTA's estimates indicate a surplus on services trade substantially greater than the official figures—$14 billion compared to $2.3 billion for 1984, the latest year for which data are available—even this surplus looks small compared to the Nation's deficit on trade in goods, $113 billion in 1984 (and $148 billion in 1986).[2] And sales by overseas affiliates of U.S. service firms exceed the Nation's service exports, probably approaching $100 billion in 1984. A foreign presence will continue to be more important for selling services than for selling goods, for reasons that lie in the nature of service products—many of which must be produced at or near the point of consumption. Easier and cheaper global communications will change this aspect of the services only slowly. Trade in goods, which can be shipped and stored, will remain much larger.

Still, many of the conventional distinctions between goods-producing and service sectors are breaking down, domestically and internationally, While the national accounts may draw a line between goods and services, companies need not, Many produce both, and sell them bundled together (although distinctions by division or line of business remain common). The firms that have emerged as major competitors in world markets for computers have succeeded largely because of their skills in providing services to customers—services that include systems integration, user training, and support and maintenance for software as well as hardware.

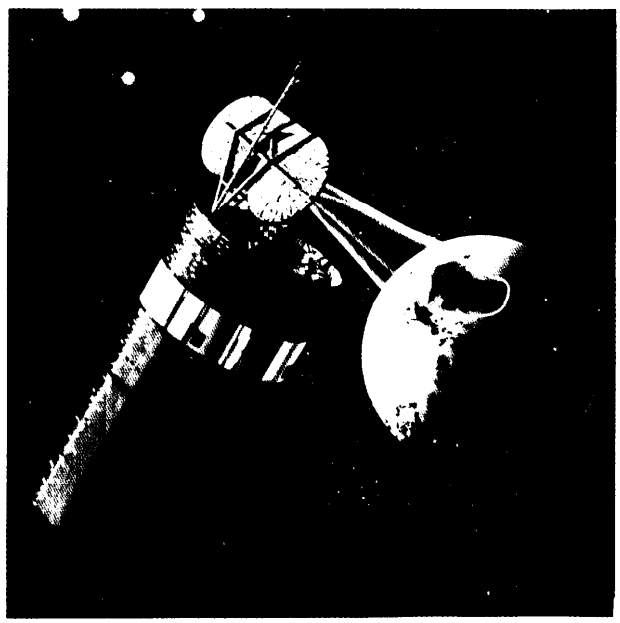
[2] OTA places 1984 service exports at about $80 billion, with imports of $66 billion—figures that exclude banking and represent the midpoint of a relatively wide range. These estimates, like the official statistics, take no account of services embodied in goods shipments, which cannot be approximated even roughly. See ch. 2, as well as *Trade in Services: Exports and Foreign Revenues*, op. cit., p. 38. Service sales of foreign affiliates of U.S. firms for 1984 could not be estimated because the data were lacking, but OTA's midrange estimates for 1982 and 1983 came to $97 billion and $92 billion, respectively (p. 41).

Software, arguably a service and now accounting for the major share of user costs in large computer systems, also comes from a rapidly growing independent industry, And of course the computer itself produces nothing tangible; its function is service—whether helping process a company's payroll or designing airplane wings.

Competitive ability in producing services has thus become a powerful factor in determining international competitiveness in manufacturing. Service revenues may give a manufacturing firm a broader range of strategic options. The productivity of people within an organization who perform service functions helps determine the ability of a firm to compete in world markets. General Motors' competitiveness depends on its assembly line workers, and also on its engineers, accountants, and truck drivers. GM bought EDS because of the latter's expertise in data processing services. Finally, GM—along with other U.S. automakers—gets substantial profits from financing new car purchases. To take another example, RCA—once but no longer a computer manufacturer—owns the NBC television network, while also making TV sets and communications satellites (and marketing the services of its satellites). GE, which likewise withdrew from computer markets years ago, builds locomotives and also markets information services to banks; GE bought RCA more for its service businesses than its manufacturing capability. Other examples: large corporations raise their own funds on the commercial paper market, bypassing their banks. Meanwhile, banks and accounting firms develop and sell computer software. E&C firms occasionally take equity positions in facilities they design and build. Multinational enterprises compete in some realms, cooperate in others, through vehicles that include international joint ventures, co-production agreements, licenses and technology sharing agreements; for years, RCA received some $50 million annually in licensing revenues from Japanese manufacturers of color televisions—a sum comparable to RCA's profits from the manufacture of consumer electronic products.

Market linkages between services and manufacturing often drive expansion in both, Production and sales of video-cassette recorders (VCRs), almost all made in Japan, have expanded at high rates; much of the growth has been fueled by U. S.-produced "software" in the form of pre-recorded tapes, As the time lag between release of motion pictures in theaters and sales or rentals of cassettes has dropped, VCRs have become a more attractive purchase. Thus sales of hardware and software, one imported, the other produced domestically, grow hand in hand. Software likewise drives sales of personal and home computers (ch. 5).

The lines separating service occupations from manufacturing occupations blur just as do those separating service firms from manufacturing firms. Growing numbers of employees in goods-producing industries perform service functions—nurses, company librarians, machine repairers, inventory clerks, computer programmers—in support of others in the parent organization or customers on the outside.



Almost by definition, high-technology goods embody high service content in the sense of knowledge and expertise (an integrated circuit, a jet engine, a newly invented biological organism). Knowledge-based services (in contrast to the traditional or tertiary services—a later section outlines the distinctions) provide a critical part of the foundation and infrastructure for the production of high-value-added manufactured goods, where U.S. export strength has been greatest.

In their domestic operations, manufacturing companies rely on service firms not only for familiar business services like advertising, accounting, contract engineering, and public relations, but to operate cafeterias and clinics, provide security guards for offices and factories, and temporary employees to help meet surges in demand. Downstream from the factory, they depend on distributors and dealers. Japanese automobile manufacturers penetrated the U.S. market so deeply in part because they built up and nourished, over a considerable period, dealer networks which today are not only extensive but highly profitable for their American owners. In the steel industry, too, growth in distribution through service centers has helped change the terms of competition; much of the foreign steel sold in the United States moves through these independent suppliers. Finally, service firms not only sell to the manufacturing sector, but the Nation's manufacturing base provides much of the necessary support for a standard of living that leads to high consumption of personal services (restaurants, entertainment, travel), thus creating additional service-related jobs.

Service exports also create new export opportunities for goods: American E&C firms operating overseas often specify American capital goods (power generating equipment, industrial process control systems). Likewise, exports of goods lead to exports of services: contracts for training and maintenance may accompany sales of Boeing jetliners (with engines made by GE or Pratt & Whitney). More subtly, for U. S.-based multinationals to take advantage of new opportunities on a global scale, they must have reasonably open access to foreign markets, not only for sales of goods and services, but for direct investments. And to capitalize on the things they do best, American firms need an infrastructure that can support globally integrated business activities–an infrastructure supplying telecommunications services, financing, advertising, insurance, and the host of other concomitants of international business. This is equally true for multinationals that are primarily manufacturers (IBM, Caterpillar) and those that are primarily service providers (Citicorp, American Express). It is also true for those that are both: given the forces operating in the world economy, managers of many U.S.-based manufacturing companies are seeking to steer their organizations toward service activities (one of the factors behind the GE-RCA merger).

Multinational Expansion and Integration

At the end of 1985, U.S. direct investment abroad stood at about $235 billion. Motives for foreign direct investment range widely. Small manufacturers seeking low labor costs establish plants in Mexico or Malaysia. Global giants like Citicorp and IBM seek new and growing markets, Sometimes investment is reactive, as firms search for an accommodation to competitive pressures (e.g., rising imports at home); sometimes it is outward-looking and strategic, At one extreme, American manufacturers may respond to import competition by subcontracting production to local firms in low-wage countries. Logistical problems—communications, coordination, transportation—often bedevil these arms-length arrangements. At another extreme —multinational integration—companies can use data processing and communications networks to link farflung operations, solving many of the logistical problems of dispersed business operations. Today, it remains easier for large companies than small to put together well-integrated multinational organizations, but this will become more practical for smaller companies as the range of marketed services expands, experience accumulates, and costs come down. Already, many relatively small high-technology firms—e.g., software suppliers—operate on a multinational basis, seeking to expand at home and abroad in parallel. When U.S. soft-

ware firms carry out product development in the United Kingdom, they do so not only to cut labor costs, but to be close to overseas markets. Later chapters explore the meaning of integration, and the implications for competition and competitiveness, in more detail.

Many U.S. Government policy makers, as well as corporate executives, see substantial benefits for the United States in multinational integration—benefits to which international agreements on services trade (and foreign investment) could make valuable contributions. In this view, such agreements, in GATT and elsewhere, emerge as highly desirable and perhaps essential for building U.S. competitiveness. Whether the businesses involved export from the United States or operate through overseas affiliates, services such as international telecommunications and data processing networks, or the foreign operations of American banks, seem vital. Indeed, some who take this view would argue that multinational integration provides the only feasible path for a country like the United States in an era of intensifying low-wage competition and rapid international diffusion of technology. OTA's analysis, in any event, suggests that maintaining high living standards in such a world requires a leading position in knowledge-based industries, services as well as manufacturing.

Despite their strategic significance, U.S. exports of services will continue to lag well behind goods exports (ch. 2). Continuing progress toward cheaper and more reliable telecommunications systems will alter processes that require production at the site of consumption only slowly. Nor can services, with few exceptions, be held in inventory, stored, or shipped overseas. Two implications follow:

- Employment in U.S. service industries does not depend heavily or directly on trade (either on exports, or on competition from imports).
- Foreign investment and sales through affiliates abroad will remain relatively more significant in the services than in manufacturing.

Nonetheless, rising service content in U.S. goods exports will help create new jobs for Americans, as will investment hereby foreign firms seeking to sell services in the lucrative U.S. market. And, if most of the *direct* benefits (e.g., employment) of foreign investment accrue to the host country, services provided by U.S. affiliates abroad lead to indirect sources of advantage for other American industries. Moreover, many of the jobs created domestically in support of overseas investments tend to be relatively skilled and well-paying (e. g., technology development, financial analysis), For such reasons, U.S. international competitiveness in the services—and particularly in knowledge-based, high-value-added services–brings substantial benefits to the U.S. economy, though these may be indirect,

Thinking About the Services

In practice, lines are usually drawn so that the category labeled services includes nearly all economic activities except production of tangible goods. Regardless of the sharpness of the lines, or just where they are drawn, the service industries comprise a group at least as heterogeneous as the goods-producing industries, and perhaps more so; certainly, production of legal services differs as much from tourism as production of paper differs from production of computers. The categories in table 4 illustrate something of this heterogeneity.

The services listed in table 4 demand a wide range of inputs. The competitive ability of a given firm in a given country will depend on those inputs and their costs (see app. B, at the end of the report). A country like Mexico, with ample low-cost labor in addition to its beaches and sun, is well-placed to capitalize on tourist travel. Medical services, in some contrast, rely on highly skilled and highly paid workers, along with expensive capital equipment. Internationally, perhaps the most significant difference between goods-producing and service industries is this: goods can be exported, while service firms must generally maintain a foreign presence to sell in foreign markets. Foreign direct

Table 4.—Classification of Service Providers by Markets

1. Intermediate markets (i.e., for services purchased primarily by business and industry)

Financial services
- • Banking (including investment banking and brokerage)
- . Insurance
- • Leasing

Shipping and distribution
- . Ocean
- • Rail
- • Trucking
- . Air freight
- • Warehousing, distribution, wholesale trade

Professional and technical
- • Technical licensing and sales
- • Architecture, engineering, and construction (including engineering design services, architectural design, construction management, and contracting)
- . Management services
- . Legal services
- . Accounting

Other intermediate or business services
- • Information technology services (including software, telecommunications, data processing, and information services)
- • Franchising
- • Advertising
- • Other (commercial real estate, business travel, security, postal and courier services, contract maintenance, . . .)

II. Services provided largely in final markets to private citizens
- • Retail trade (including restaurants)
- . Health care
- . Travel, recreation, entertainment
- • Education
- . Other social services, including government
- • Other Personal services

SOURCE Off Ice of Technology Assessment, 1987

investment may be desirable in manufacturing; it is essential in many of the services.

In this assessment, intermediate or business services (category I, services produced and sold to other businesses) get most of the attention. With some exceptions in "other" services, as well as in shipping and distribution, most of the intermediate services in table 4 are knowledge-based and skill-intensive—i. e., they depend on technology. The second category (services provided largely in final markets to private citizens) also includes high-skill, high-wage, and technology-dependent industries such as health care, along with a variety of "low-technology" services,

Plainly, all such distinctions remain arbitrary, Banks employ many tellers with relatively low skills and low pay. Familiar industries—retailing and advertising, tourism and transportion, architectural design—depend on a continuous stream of technology-intensive innovations [automated inventory and ordering systems, computerized reservations and ticketing, computer-aided drafting, database management systems for engineering changes and bills of materials). American banks move funds around the country and around the world via electronic networks. Computer systems provide analytic support for decisions made by air traffic controllers and bank officers. In many of these applications, computers enhance human skills (e.g., by helping people deal with complexity in rapidly changing environments). In other applications, computer systems rationalize production in far more mechanistic ways–examples include automated warehouses and the back offices of banks, where huge volumes of checks must be processed quickly and cheaply. Here, the systems tend to *replace* human skills, as well as augmenting them in the sense of helping people do straightforward jobs faster.

Broadly speaking, technology is so pervasive in advanced economies that most foreign sales by U.S.-based companies, whether provided through exports or foreign affiliates, depend in some sense on technical expertise. Moreover, the services provided in conjunction with sales of goods such as commercial aircraft, or computer and telecommunications systems, follow directly from the technology embodied in the goods—e.g., training in servicing procedures for jet engines, or in maintaining systems software. At various points in this assessment, then, knowledge-based services are distinguished from more traditional or *"tertiary"* services, the latter including such industries as trade and distribution. Table 5 summarizes the distinctions between knowledge-based and tertiary services, while table 6 reclassifies service industries on this basis.

Like the classification by markets in table 4, ambiguities and exceptions can be found in table 6, but the distinction between knowledge-

Table 5.—Characteristics of Knowledge-Based Compared to Tertiary Services

Knowledge-based services	Tertiary services
High *skii/* levels (as measured, for example, by years of education) and relatively high *pay.* Many professional and paraprofessional jobs. Continuing learning often important,	Low *skii/ levels* and educational requirements; low pay. Upward mobility may be quite limited.
Either the product or the production process, or both, depends on relatively advanced technologies. In many cases, digital computers have become integral to the production of the service (data processing itself, computer-assisted architectural drafting). Typically, computers are used to *enhance* people's skills. Control over the system (and the production process) may be distributed through the organization.	While advanced technologies may have a prominent role in the product/process environment, in general neither the nature of the service nor the nature of the production process is affected by the technology in a fundamental way (electronic cash registers as direct replacements for electro-mechanical; food preparation using pre-programmed equipment). Typically, the computer serves to *rep/ace* human skills, with control concentrated at management levels.
Often though not always an *intermediate service,* supplied to other businesses.	Frequently a service *provided in final markets to individuals,* sometimes to businesses (custodial services, private security guards).
Provision of the service often demands rapid response to shifting customer needs. (It may begin with the elicitation of those needs.) Flexibility (in *volume* of output, in design of that output, hence in response to customer needs) may become a major competitive weapon. Both product and process can involve substantial customization to meet market requirements, implying high information/knowledge content.	The service tends to be *standardized,* the production process more-or-less fixed and routine,

SOURCE Off Ice of Technology Assessment!, 1987

Table 6.— Examples of Knowledge-Based and Tertiary Service Industries

Knowledge-based	Tertiary
Banking	Leasing
Insurance	Shipping and distribution (all, in - cluding wholesale trade)
Professional and technical (all)	Franchising
Information technology services (all)	Retail trade
Advertising	Travel, recreation, much enter tainment
Motion pictures	Social services (some)
Health care	Personal services (most)
Education	
Government (some)	

SOURCE Office of Technology Assessment 1987

based services and the traditional or tertiary services helps identify sectors where a high-wage, high-skill economy like that of the United States can expect to be competitive internationally. At the same time, given the heterogeneity of the services, it makes little sense to speak of an economy being competitive in the services as a whole. Over time, just as in manufacturing, some service industries will gain internationally, while others lose.

Using Technology

U.S.-based service companies have often had technological advantages that translate into competitive advantages. Today, protecting those advantages is harder than ever. Goods, services, people—all carrying technology—migrate with relative freedom through a world economy that is largely open, with national economies interpenetrating one another, primarily through the activities of international businesses.

The technology and science base underlying the service industries, which centers on modeling of product designs and production processes, overlaps that for manufacturing (box B). While products and processes differ greatly between the services and manufacturing (and among the services), many of the techniques remain similar, Computer-based decision models for buying and selling stocks, to take a widely publicized example, find parallels in factory automation, as well as in management of telecommunications networks, When it comes to applications of computers and communications

BOX B.—The Technology / Science Base for the Services

Narrowly defined, the technological foundation for the service industries begins with models, the more useful of them mathematical. These models abstract from systems, both simple and complex (the system could be a food store or an international currency market), helping people predict their behavior. For a simple example-which is not to say the modeling is simple--consider a retail clothing store, whose owner might want to determine desirable inventory levels and reorder intervals, staffing needs, whether it pays to open on Sunday. Seasonal selling patterns, predictions of local and national economic growth, even long-term weather predictions, might help him decide how many winter coats to order, whether to hire and train new staff in expectation of booming business, and whether to negotiate a 6-month bank loan to finance inventory or rely on a revolving line of credit. A related problem might be to locate a new store within a growing urban area. Predictions of growth patterns and concentration of future shopping activity would help the owner decide where to put the store, and how much rent he could afford.

Only in the simplest cases could the store owner expect a full and immediately useful answer to his questions, yet imperfect information and heavily quaified results, provided he understood their limitations, would help him guide the business. Mathematical modeling based on knowledge of the physical sciences normally gives more accurate results. When a manufacturing company relies on engineering models to predict the performance of a newly designed home air-conditioner-e. g., its energy consumption-the predictions will be close to actual performance. But they not be the same, and critical decisions (whether the new design performs enough better than the old) will always depend on actual tests. Note that the air-conditioner manufacturer will also rely on models like those useful to the retailer-consumer buying habits, the economic outlook, seasonal weather forecasts, optimal inventory levels.

Technology, then, in the services as in manufacturing (and mining and agriculture), begins with a science base, eclectically assembled to meet the needs of the industry. The science base underlies the models. The next and critical steps consist in knowing which models use for a given purpose, how to use them defectively, when to accept their predictions and when to disregard them.

Thus there is much more than modeling to technology in its broader dimensions: only in simple cases will the decision be automatic (the store will run out of canned peas n@ Saturday unless we reorder now). People make decisions based on what they know and can articulate-which includes the output of analytical procedures—combined with tacit knowledge instinct, and intuition, some of which they will not even be aware of calling on. This is part of technobgyo, viewed as know-how and expertise. In this view, people embody technology, both individuallyand collectively.

In most of the services, knowledge traceable to the science base will be less reliable as a guide for decisions than in goods-producing industries. What people "know" but cannot necessarily explain becomes correspondingly more important. Moreover, it is collective know-how and institutional decisionmaking that count in determining competitive outcomes-while a bade will depend more heavily on the collective knowledge, much of it intangible, of its staff than a construction company or a manufacturer of air-conditioners (which does not by any means make tacit know-how unimportant for the latter).

Many of the models deg ‘opedrin the pastnafor dealinng industries could be handled with paper-and-pencil mathematics. This was adequate forigrángDC-3, even a nuclear powerplant; complex calculations that can onlytemptecon digital computers bring refinements, but only occasionally realltechnical. In the services, more of the models will exceed the limits of paper and pencil if they are to be useful. Many phentheento be modeled—e.g., Peep!@'s behavior—must be treated statistically. Typically, this requires processing a good deal of empirical data—one of the things computers do best.

Computers excel at storing and manipulating large volumes of data and information—orders and inventory levels in a chain of retail stores, financial transactions in banks. They can also implement complex algorithms for recognizing print or simple spoken language. Beyond these transactional applications, new analytical uses of computers, primarily for supporting managerial decisionmaking, are rapidly becoming important for competitiveness in the service industries (as discussed in box C). Companies that utilize such techniques effectively-i.e., rely on them when appropriate, disregard them when not—will come out ahead. As always, appropriate use of technology will depend on judgment and experience.

The Federal Government—for instance, in its compilations of R&D statistics, and in policies for R&D tax credits—has not fully recognized the technology/science base for the services. But that lack of recognition, and the perception that service companies do market research rather than R&D, should not be allowed to hide the extent to which service industries depend on the tools of mathematics and other sciences. Estimates in chapter 9 suggest that annual U.S. R&D spending related to the services totals perhaps $26 billion, more than 10 times the figure published by the National Science Foundation as representing U.S. nonmanufacturing R&D.

systems, the contrast between analytical applications, such as computer-based stock trading, and transactional applications, in which the system does little more than keep track of large volumes of information, yields further insights into the place of technology in the services. Box C amplifies on this contrast.

As box C suggests, new technologies change the ways in which firms organize work, Digital data—sometimes information, sometimes meaningless noise—already permeates firms in the advanced industrial economies. Even quite small companies depend on electronic databases, automated production control systems, telecommunications services. Software itself, a service by some criteria, a good by others, symbolizes many of the ongoing shifts. Sitting between the system and the people who use it, software tells the computers what to do, controlling the interactions between people and machines. Software and system designers help shape corporate organizations, the contours of jobs, the channels of power and influence within the firm. But software no longer consists exclusively of pre-determined programs with a fixed logical structure. With distributed computing and fourth-generation languages, software—and hence the system as a whole—becomes more fluid. As these new approaches evolve, computer-literate experts will lose some of their control over the configuration of the system; in principle, many people could gain at least limited ability to modify and customize the software they work with.

Given this ability to use computer technology—either to enforce conformity with rigidly structured work procedures, as in the back office of a bank (analogous to an assembly line), or to enhance people's independent problem-solving capabilities, as in the bank's front office or in a computer-aided design laboratory—a "new" manufacturing enterprise may look more like a knowledge-intensive service firm than an "old" manufacturing enterprise. A modern steel producer, utilizing ladle refinement, vacuum degassing, and argon gas stirring, followed by continuous casting, to produce high-strength steels with lean alloy content, will be heavily dependent on sophisticated control models to regulate melt chemistry, mold levels, and rolling practice. In a sense, such a facility may have less in common with a steel manufacturer still relying on 1960s-era technology than with a hospital laboratory that uses automated sensors, analytical instruments, and recording devices to perform an individually specified test series on blood samples. Two basic dimensions to the use of computer technologies in business organizations follow:

- information/knowledge content, the extent to which the firm depends, in its products

Box C.-Computer Applications in the Services

As noted in box B, the service industries use many of the same technological tools as manufacturing. Structural design for bridges, dams, and buildings-undertaken by E&C firms-does not differ fundamentally from structural design for aircraft or for artificial hip joints. In both, the laws of physics provide the starting point for design methodologies that, today, often include finite element codes for stress and deflection analysis-codes that can only be run on powerful computers. Designing an office building to minimize operating costs (e.g., for lighting, heat, and cooling), given constraints on floor area and construction costs, means calculations for heat transfer and thermal management. In the telecommunications industry, computers help find optimum solutions for network design problems.

But what about services like banking and insurance, not to mention retailing and fast foods? Today, not only may the corner grocery do its bookkeeping on a personal computer, but supermarket chains use simulations to find the right number of check-out lines for a given store. An international construction company can manage an onsite inventory of piping, valves, and fittings worth millions of dollars, with large savings in its costs. Of these three examples, the first and last can be considered *transactional,* meaning that the primary task for the computer system is to keep track of large volumes of data. While arithmetic and simple logic will be part of this—e.g., in bookkeeping—mostly the computer is managing information flows. The second example differs; it is an analytical application, meaning that the computer performs calculations using a mathematical model (box B). None of the simplifications typical in such models are allowed in bookkeeping, although analytical applications might well be part of the software for managing onsite construction inventories (e.g., procedures for minimizing materials handling costs).

Transactional applications as part of ongoing business operations tend to be simple in principle but demanding in practice, particularly when databases are large and rates of information flow high. Although originally developed to reduce costs and increase productivity by automating existing jobs, transactional applications also yield strategic advantages through better customer support and service. For example, some companies are beginning to locate terminals on the premises of their customers. Not only can the customers place orders at their convenience, they can use the system to track shipments and otherwise manage their inventory levels. Other examples include fundamentally new products such as the cash cards used in automated banking.

Analytical applications, which can be replete with empirical data representing human behavior in at least some of its random messiness, stem more directly from the technology / science base underlying the services. Drawing in some cases on social and behavioral sciences, the unifying element once again is mathematical modeling, Whether it is queuing theory (as in the supermarket example), linear or nonlinear programming (as in the well-known traveling salesperson and warehousing problems), or economic modeling (e.g., business forecasts), the models run on computers, often some of the most powerful machines available.

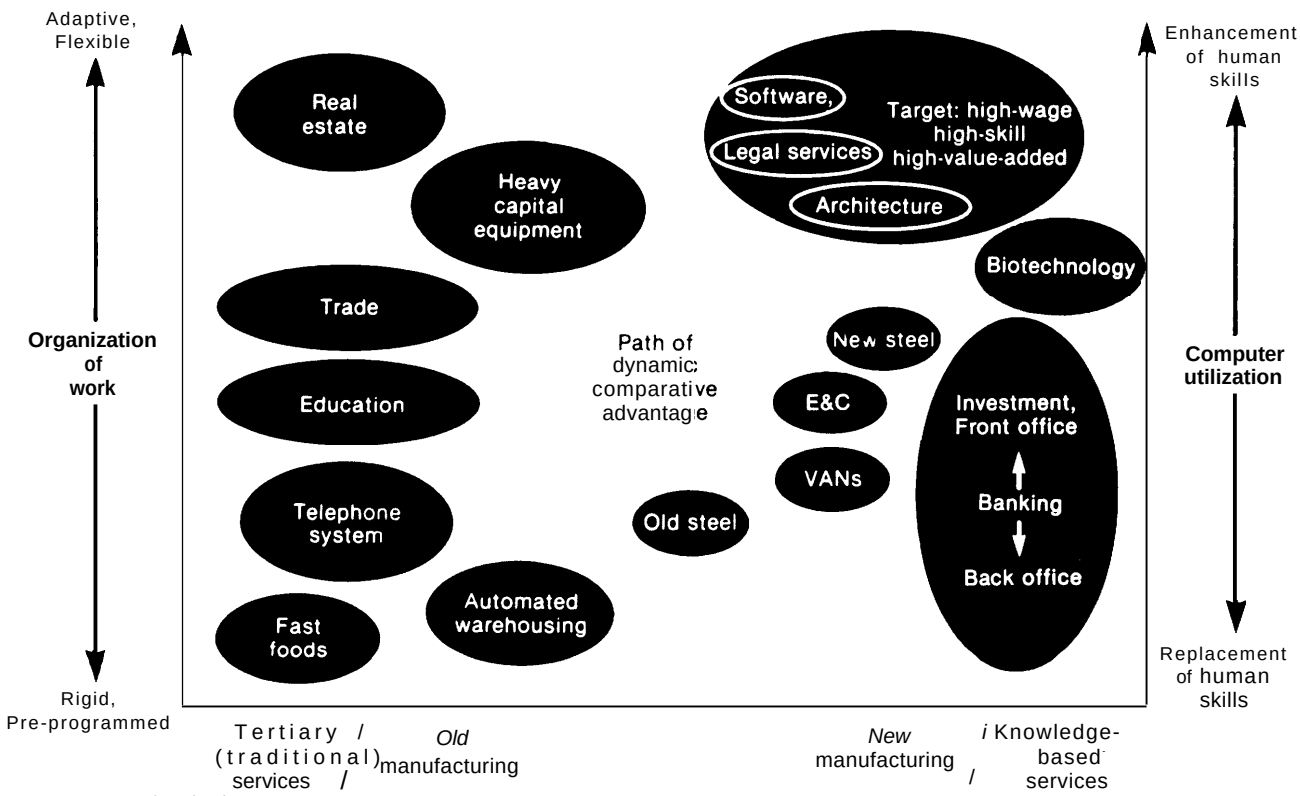
Like transactional applications, analytical applications of computers open up strategic alternatives but may also simply cut costs. The supermarket can predict not only how many check-out lines it needs, but how many checkers to call in as a function of the day of the week and the time of day. In many service industries, future international competitiveness will depend on both transactional and analytical applications of computer systems, and on telecommunications systems for linking these computers.

and/or its production processes, on technical expertise, know-how (whether well-codified, as in a computer program, or tacit, as in people with experience, well-honed skills, good judgment), and inputs of data and information (e. g., from process control sensors); and
- work organization, ranging from rigidly programmed or rule-based, as for telephone operators, to flexible and adaptive, as in the groups of more-or-less autonomous professionals who work in investment banks or R&D laboratories. (Note that, today, computer technologies may be indispensable at both ends of the work organization spectrum, but they are used to regulate and/or replace human abilities at the one end, to support and enhance people's skills at the other).

Figure 6 includes examples of both manufacturing and service industries ordered on such dimensions. In essence, the horizontal axis takes the distinctions summarized earlier in table 5 between tertiary and knowledge-based industries, spreads them along a continuum, and adds a similar distinction between "old" and "new" manufacturing. Information/knowledge content cannot be measured precisely, but is closely related to customized production—whether of legal services, computer software, or a batch of low-sulfur, low-phosphorous steel with high resistance to lamellar tearing. (These distinctions are examined in more detail in ch. 8, as are the work organization and computer utilization dimensions along the vertical axes.)

Moving from lower left to upper right in figure 6 corresponds roughly to the direction of change in the U.S. economy since the close of the Second World War. These changes will continue; indeed, as the figure suggests, an ongoing shift seems necessary if the United States is to remain competitive in high-skill, high-

Figure 6.—Characteristics of Firms and Industries



SOURCE Office of Technology Assessment, 1987

wage, high-value-added industries—with the higher living standards this implies, The movement is not so much from manufacturing toward services as from one set of manufacturing and service industries to another, and from one set of internal attributes in each sector to another. The United States does not need to evolve toward a service economy. It does need to move toward a high-skill economy.