CHAPTER 4

Measures of Competitiveness in the Three Industries

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Overview

No single indicator suffices for comparisons of competitiveness across industries, for reasons discussed in appendix A. This chapter uses a number of indicators to examine the ways in which the American steel, electronics, and automobile industries differ in their competitive postures.

These industries compete with each other as well as with their foreign counterparts. They compete to generate capital, for the public policies they find desirable, and in their productivity improvements—because firms and industries that increase productivity faster than the national average can improve their competitive position. The following discussion addresses the competitive ability of each industry primarily in comparison with other domestic industries because of the primary role of domestic position as a determining factor in international competitiveness.

The first of the indicators used—international trade flows as measured by import penetration or exports as a percent of domestic production—shows that computers are the most competitive of these sectors, consumer electronics the least. Steel and automobiles are also lagging on this measure, while imports of semiconductor products exceeded exports for the first time in 1978,

Productivity data as indications of competitive ability are less straightforward; but, for most of these sectors lagging productivity does not appear to have been a major problem. The computer industry, which is very strong in terms of exports, shows unusually high labor productivity—despite a history of decreasing prices relative to technological capability. However, the consumer electronics sector, which has suffered severe import penetration, has increased its productivity about as fast as U.S. manufacturing in the aggregate—hence on this measure shows no real slackening of competitiveness. The situation is somewhat similar for steel, although here there is some evidence of lagging productivity. Automobiles exhibit productivity which is increasing significantly faster than for U.S. manufacturing as a whole. By themselves, productivity trends do not explain why the steel and automobile industries should be suffering on trade measures.

Insight into the problems of the American steel industry comes from comparing rates of increase in wages. Wage rate increases have outstripped productivity advance—in part because the industry has not modernized its plant and equipment rapidly enough for increases in productivity to keep up with those in wages. The automobile industry's current difficulties have other sources. Nonprice factors—such as the turn towards small cars with good fuel economy—are important causes of the recent increases in import penetration, Semiconductors and computers continue to look strong on all of the measures examined in this chapter,

The last section examines generalized indicators of competitive ability, including trends in R&D spending. Such measures exhibit worrisome trends, but are not by themselves conclusive signs of competitive problems for American industry.

International Trade Data

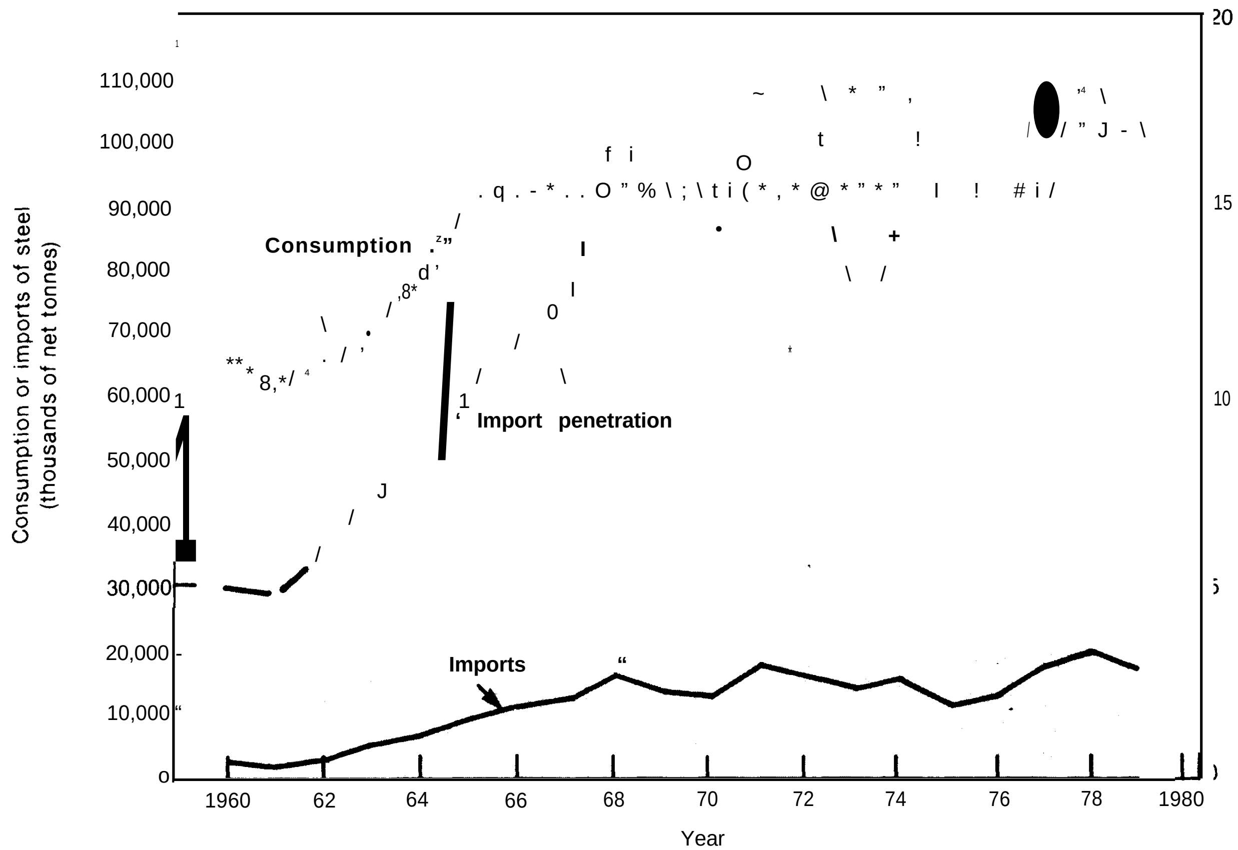
The trade balance in a particular sector is one of the fundamental indicators of competitiveness. During the 1970's, the U.S. share of world exports of manufactured goods fell from over 20 percent to about 17 percent.[1] However, the U.S. dependence on exports is not as great as that of many other industrialized nations. Although the ratio of exports to gross national product (GNP) for the United States nearly doubled during the 1970's—from 4.3 percent in 1970 to 7.5 percent in 1979, this is still less than half the percentage characteristic of many Western European countries (though about half of all exports by European Community nations stay within the Common Market). Contrary to popular belief, Japan is not unusually dependent on exports; the ratio of exports to GNP in that country has remained at about 10 percent in recent years,[2]

Turning to the three U.S. industries, figures 1 and 2, along with tables 2 through 6, show imports, exports, and production or sales (consumption). For simplicity, exports of steel, consumer electronics, and motor vehicles are omitted, as these are much smaller than imports. Imports of computers are likewise negligible compared to exports, and have not been included in table 4. (Motor vehicles exported to or imported from

[1] *International* Economic Indicators (Washington, D.C.: Department of Commerce, International Trade Administration, September 1980), p. 34.

[2] Ibid., p. 36.

Figure 1.— U.S. Consumption and Imports of Steel



SOURCE Annual Statistical Report, American Iron and Steel Institute, various years, steel only

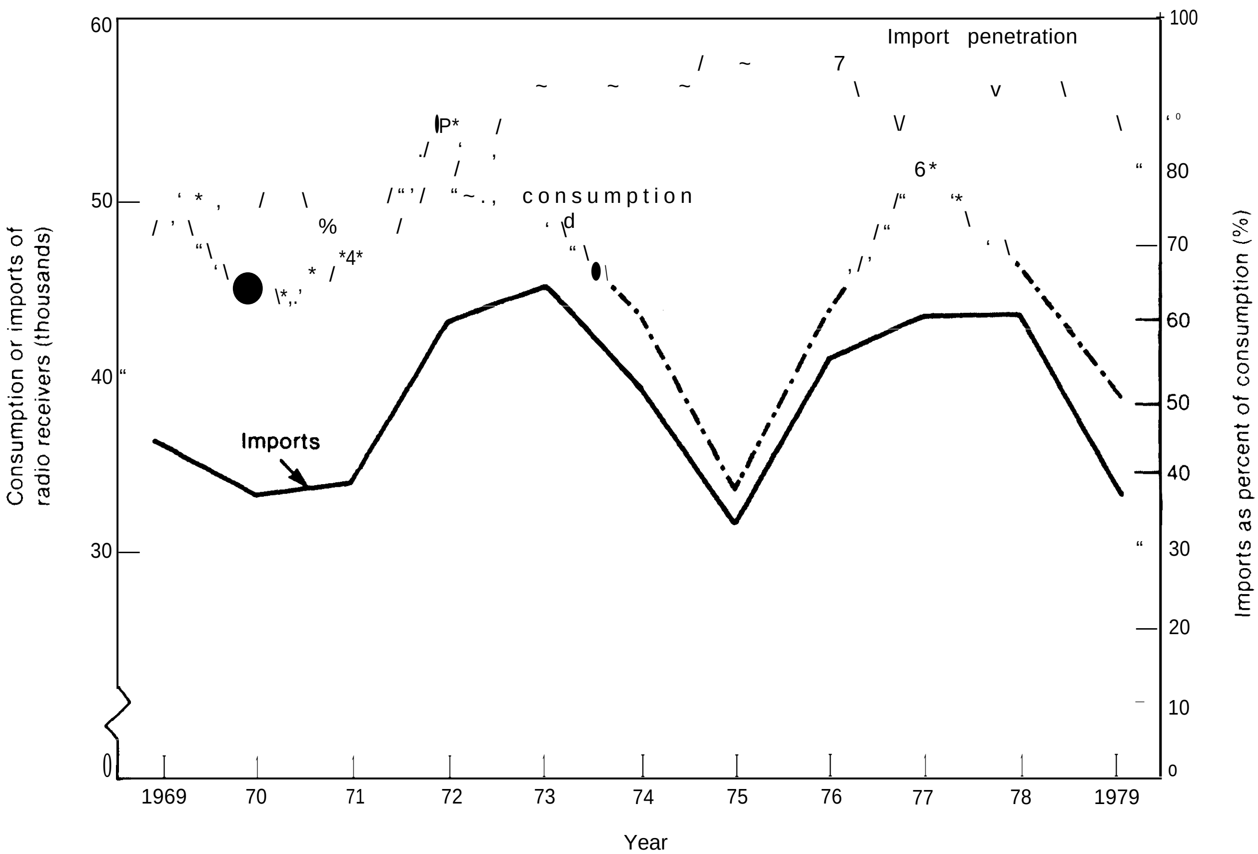
Canada have been excluded from the discussions of trade flows throughout this report because all production in Canada is by subsidiaries of U.S. firms and there is extensive trade both ways between parent firms and subsidiaries.)

The data show that these industries differ markedly in the extent to which imports have penetrated U.S. markets. In steel (figure 1), imports have taken a significant share of domestic markets for more than 15 years, although the percentage has fluctuated considerably, Substantial amounts of steel also enter the country embodied in imported cars and trucks.

Figure 2 and table 2 contain import data for two important consumer electronics products: radios and TV receivers. Most of the radios and black-and-white TVs sold in the United States are imports; the fraction ran well over half throughout the past decade. Color TV imports peaked in 1976, but were then discouraged by Orderly Marketing Agreements, negotiated first with Japan in 1977, then with Taiwan and Korea in 1979. Many components used in color TVs continue to come from abroad.

The pattern for semiconductors is shown in table 3, which includes exports as well as imports. Trade in both directions has grown, while the total market has been expanding rapidly. A great deal of this trade consists of interdivisional shipments between the domestic plants and foreign subsidiaries of U.S. firms. Semifinished devices are sent abroad for labor-intensive operations such as wire-

Figure 2.— U.S. Consumption and Imports of Radio Receivers



SOURCES Calculated from *Electronic Market Data Book 1980* (Washington, D.C.: Electronics Industries Association, 1980)

Table 2.—Domestic Sales and Imports of TV Receivers (thousands)

	Total TV sales		Imports		Imports as Y. of total sales	
Year	Black & white	Color	Black & white	Color	Black & white	Color
1968	5,551	6,032	2,043	'666	36.80/0	11.00/0
1970	4,546	4,822	3,596	914	79.1	18.9
1972	8,145	8,378	5,056	1,318	62.0	15.7
1974	5,941	7,380	4,659	1,282	78.4	16.3
1975	4,968	6,485	2,975	1,215	59.8	18.7
1976	5,196	7,700	4,327	2,834	83.2	36.8
1977	5,664	9,107	4,908	2,539	86.6	27.8
1978	6,064	10,236	5,931	2,775	97.8	27.1
1979	6,254	9,846	5,874	1,369	93.9	13.9

;OURCES *Electronics Market Data Book* 1980 (Washington, D C Electronics Industries Association. 1980) PP 10 and 33; Television Receivers, Color *and Monochrome, Assembled or Not* Assembled, *Finished or Not Finished,* and Subassemblies Thereof (Washington. D.C. U.S. International Trade Commission, publication 808, March 1977), 1968 approximate

Table 3.— Domestic Consumption and Foreign Trade in Semiconductors (millions of dollars)

Year	Domestic shipments	Exports[a]	Imports[a]	Domestic consumption	Exports as % of production	I reports as% of production
1968	$1,415	$ 204	$72	1,283	14%	6%
1970	1,720	417	157	1,460	24	11
1972	1,848	470	330	1,708	25	19
1974	3,646	1,247	961	3,360	34	29
1975	3,002	1,053	803	2,752	35	29
1976	4,310	1,400	1,107	4,019	32	28
1977	4,363	1,497	1,352	4,218	34	32
1978	5,312	1,528	1,680	5,464	.29	31
1979	6,852	2,065	2,266	7,053	30	32

[a]Both exports and Imports include semiconductors exported for further processing and then reimported Such devices, usually shipped between divisions of the same company, appear both as exports and as Imports

SOURCES 1968.72—A *Report on the Semiconductor Industry* (Washington, D.C *Department* of Commerce Industry and Trade Administration, September 1979)
1974-79*—Electronics Market Data Book 1980* (Washington, D C : Electronics Industries Association, 1980), PP 104 and 113

bonding, then reimported to the United States (or sold in other markets); of the $1.35 billion in imports in 1977, $1.12 billion (83 percent) were intracorporate sales.

U.S. shipments plus exports of computers are given in table 4. The trade surplus of the United States in computers is greater than the deficit for all consumer electronics (which includes more than just radios and TVs and was about $3.6 billion in 1979). In addition to exports from the United States, American computer manufacturers have large sales through foreign subsidiaries. Over two-thirds of all the computers that have been installed in Europe originated with American-owned firms. In contrast, virtually none of the computers in the United States have been designed and/or built by foreign firms. As for the steel that enters the United States incorporated in imports such as automobiles, many semiconductors leave the United States as components of computers and other electronic systems. Semiconductors also enter this country via imported consumer electronics products.

Table 4.—Domestic Production and Exports of Electronic Computers, Parts, and Accessories (millions of dollars)

Year	Product ion	Exports	Exports as % of production
1970	$ 5,671	$1,236	21 .8%
1975	8,443	2,228	26.4
1976	10,134	2,588	25.5
1977	13,398	3,264	24.4
1978	17,100	4,128	24.1
1979	20,850	5,250	25.2

SOURCES *1970-77—Sfaf~stlca/ Abstract of the United States, 7979* (Washington, D C Department of Commerce, Bureau of the Census, 1979), p 868
1978.79— 1980 U S *Idustrial Outlook* (Washington, D C Department of Commerce, Industry and Trade Administration, January 1980), p 252

For automobiles (table 5), import penetration was relatively low during the 1960"s, but during the 1970's imports increased markedly. In 1980, automobile imports took more than 25 percent of the market, Imports of trucks have also increased, as table 6 shows. Most of these are small pickup trucks made by Japanese firms.

In isolation, these tables and charts would indicate that the United States is more competitive in steel than in automobiles, and more competitive in computers than in consumer electronics. They emphasize that import penetration in the range of 15 percent for steel is nothing new, However, the use of highly aggregated figures such as those in the tables does not give a complete picture. Table 5, for example, does not indicate that almost all imported cars are compacts or subcompacts, sectors in which imports claim roughly 40 percent of the market—import penetration in small cars remained above 30 percent throughout the 1970's. Total import penetration has gone up largely because the small car market has become a greater part of the whole. In fact, imports have captured most o.f the growth in the U.S. automobile market since the 1960's.

"'Current Problems of the U.S. Automobile Industry and Policies to Address Them, " staff working paper (Washington, D. C.: Congressional Budget Office, Natural Resources and Commerce Division, July 1980), p. 14.

Table 5.—U.S. Automobile Production, Total Sales, and Import Sales (thousands)

Year	U.S. production	Total new car sales	Import sales	Imports as % of total sales
1960	6,703	6,576	499	7.6%
1965	9,335	9,313	569	6.1
1968	8,849	9,404	986	10.5
1970	6,550	8,388	1,231	14.7
1971	8,558	9,831	1,466	15.1
1972	8,828	10,488	1,529	14.5
1973	9,667	11,351	1,720	15.2
1974	7,310	8,701	1,369	15.7
1975	6,741	8,262	1,501	18.2
1976	8,538	9,751	1,447	14.8
1977	9,294	10,826	1,968	18.3
1978	9,153	10,946	1,946	17.8
1979	8,418	10,335	2,339	22.6
1980	6,373	8,977	2,398	26.7

SOURCES: *1980.79-Automotive News 1980 Market Data Book Issue.*
1980—Ward's *Automotive Reports* Jan 12, 1981

Table 6.—U.S. Truck Production, Total Sales, and Import Sales (thousands)

Year	U.S. production	Total new truck sales	Import sales	Imports as % of total sales
1973	3,002	3,176	162	5.1940
1974	2,694	2,884	244	8.5
1975	2,260	2,330	144	6.2
1976	2,993	3,280	269	8.2
1977	3,487	3,807	240	6.3
1978	3,722	4,264	374	8.8
1979	3,053	3,540	404	11.4
1980	1,639	2,487	485	19.5

SOURCES: *1973-79—Petition for Relief Under Section 201 of the Trade Act of 1974 From Import Competition From Imported Passenger Cars, Light Trucks, Vans, and Utility Vehicles,* submitted by the International Union, United Automobile, Aerospace, and Agricultural Implement Workers of America (UAW), before the U.S. International Trade Commission, June 12, 1980, p. 196.
1980— *Ward's Automotive Reports,* Jan. 12, 1981.

Nor does table 3 indicate some of the more worrisome trends in semiconductor trade. During 1980, Japanese imports evidently took more than 40 percent of the market for a particular state-of-the-art integrated circuit—the 16K RAM. This is a random access memory circuit used mostly in computers and capable of storing over 16,000 bits of information.

Productivity

Another measure of an industry's ability to compete internationally is the degree to which its labor productivity—defined as value-added per worker-hour or physical output (units, tonnes, ., .) per hour—has kept pace with other domestic industries. (Capital markets in various countries are now more strongly linked than in the past; although differences in costs of capital exist, labor costs and labor productivity are usually more important for competitiveness than capital costs and capital productivity.) In general, industries with lower-than-average productivity growth can expect increasing competition from abroad. Footwear and apparel are examples of American industries with seriously lagging labor productivity; neither is competitive internationally.

The productivity comparisons in this section are between domestic industries; they do not juxtapose U.S. and foreign industries. As explained in appendix A, direct international comparisons are not meaningful for competitiveness unless related to aggregate productivity changes in the two countries. For example, if aggregate productivity in Japan were to double compared to the United States, a particular Japanese industry would have to more than double in productivity to improve its relative position. This is because the exchange rate should shift—at least in principle—to account for aggregate productivity differences between the two countries.

The particular measure of productivity chosen also affects comparisons of competitiveness. Two productivity indexes are used below: 1) value-added per production-worker-hour: and 2) the standard productivity index of the Bureau of Labor Statistics (BLS), physical output per employee-hour.

No single indicator of productivity is totally satisfactory. Value-added figures are heavily influenced by differences in industrial structure and by the extent of competition within the industry. This is because a firm's ability to determine its own prices can affect value-added. More monopolistic industries would be expected to exhibit higher value-added, everything else being equal, Moreover, in some industries prices may include costs that are not directly related to manufacturing. Computer prices often contain implicit charges for software which is ostensibly provided free. This inflates the value-added per worker-hour figure, because software programmers are not counted as production workers.

The BLS productivity data, based on physical output per employee-hour, also have limitations, Most important, they are restricted to labor content; none of the other factors affecting productivity are accounted for. While the time spent by all employees is included, not just production workers, the effects of capital investment—for instance, in new process technologies—or of rates of capacity utilization, are hidden. Such factors affect output per employee-hour in some industries more than others. In an industry such as steel, the extent to which plant and equipment operate at full capacity varies from year to year, productivity being higher at close to full capacity. Therefore, long-term trends are more meaningful than year-to-year variations.

Table 7 gives value-added per production-worker-hour for steel, three sectors of electronics, and motor vehicles. In addition, aggregate data for all U.S. manufacturing are included. Much of the apparent increases in

Table 7.—Value”Added per Production-Worker-Hour (current dollars)

Year	Steel	Electronics: Radio/TV receivers	Electronics: Semiconductors	Electronics: Computers	Motor vehicles	All U.S. manufacturing
1960 . . .	$ ‘8.23	$ 6.40	$ 8.64	na	$ 9.57	‘$ 680
1965 . . .	10,27	7.52	11.48	$15.83’	12.08’	8.50
1970 . .	11,37	10.64	16.11	21.18	15,42	11.30
1975 ., .,	20.31	16,02	21.00	32.15	23.36	18.40
1976 . .	21,67	20,84	24.10	42,42	28.30	20.20
1977	22.49	22.81	27.40	45.20	30.14	21.90

na = not available
[a]Estimated

SOURCE Census of Manufacturers various editions Data for semiconductors for 197577 Annual Survey of Manufacturers

productivity are simply inflation. Figure 3 shows the productivity in each industry as a percentage of the all-manufacturing average, calculated from the data in table 7. The plot gives direct comparisons between each sector and the rest of American industry. thus compensating for the effects of inflation.

For steel, figure 3 shows a slow decline in value-added productivity relative to other industries over the decade of the 1960”s. Absolute productivity remains above the all-manufacturing average, but disregarding fluctuations such as those caused by year-to-year changes in capacity utilization, a gradual downward trend is evident, particularly during the latter half of the 1960’s. Relative productivity remained low during the 1970’s, except for 1974 when there was a large price rise. Imports quadrupled in tonnage during the 1960’s, and tripled as a percentage of American steel consumption. This increased competition, together with Government price controls (ch. 6), helped keep prices down, decreasing value-added productivity compared to the rest of U.S. industry.

Relative value-added productivity for the motor” vehicle industry (figure 3), though falling somewhat in recent years, has remained consistently farther above the all-manufacturing average than for the steel industry. There are two primary reasons. First, automakers have been somewhat freer to raise prices as costs increased. Second, the productivity of the auto industry has also been increasing rapidly on a physical output basis (as shown by the BLS productivity data which follow).

In the three electronics sectors, the value--added per worker-hour data present a mixed picture, The computer industry shows consistently high productivity (figure 3), roughly twice the all-manufacturing average. This is especially noteworthy because prices for computing capability have been falling. One reason for the high performance on this measure is the large number of technically trained personnel in the computer industry. These employees are not included in the production worker category, thus increasing the productivity ratio. An additional point is that computer prices must cover large costs not included as production expenses, notably for engineering and software. This overhead is a higher proportion of total costs than for most other manufacturing industries. Finally, one company, IBM, has long been dominant, and the industry pricing structure may be less competitive than would be true in, say, steel.

The semiconductor sector is similar to the computer sector in being R&D-intensive, which again increases productivity on a production-worker-hour basis because the time spent by engineers and other R&D personnel is not included. On the other hand, price competition is stronger than in computers, so much so that many of the labor-intensive portions of semiconductor manufacture have been transferred abroad. This is one reason why the productivity figures for semiconductors in table 7 and figure 3 are not particularly high—in general being less than for automobiles, though greater than for steel. However, productivity in the semiconductor industry, as for computers, is notoriously dif -

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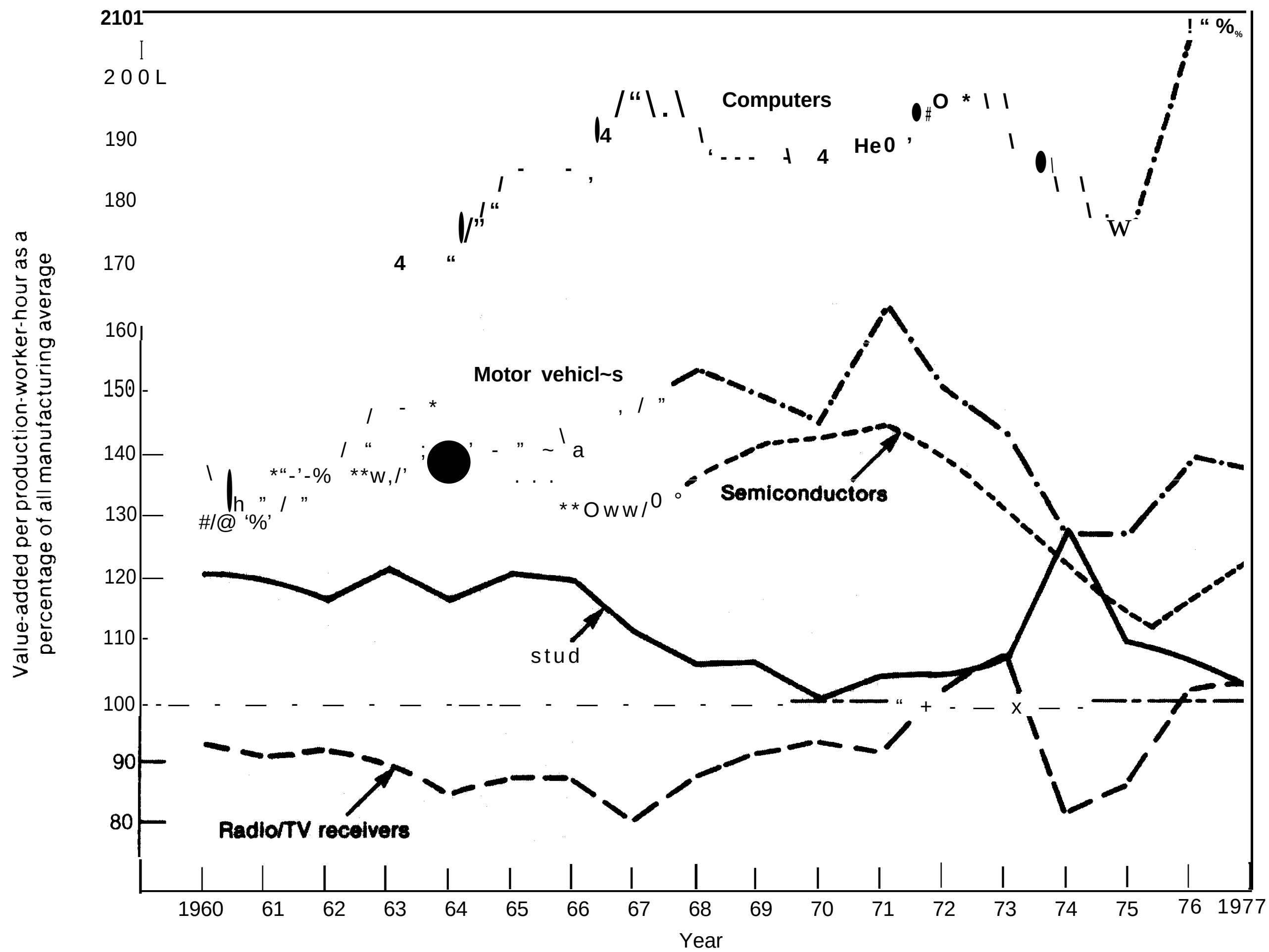
Figure 3.— Value-Added Productivity of U.S. Industries as Percent of All Manufacturing Average



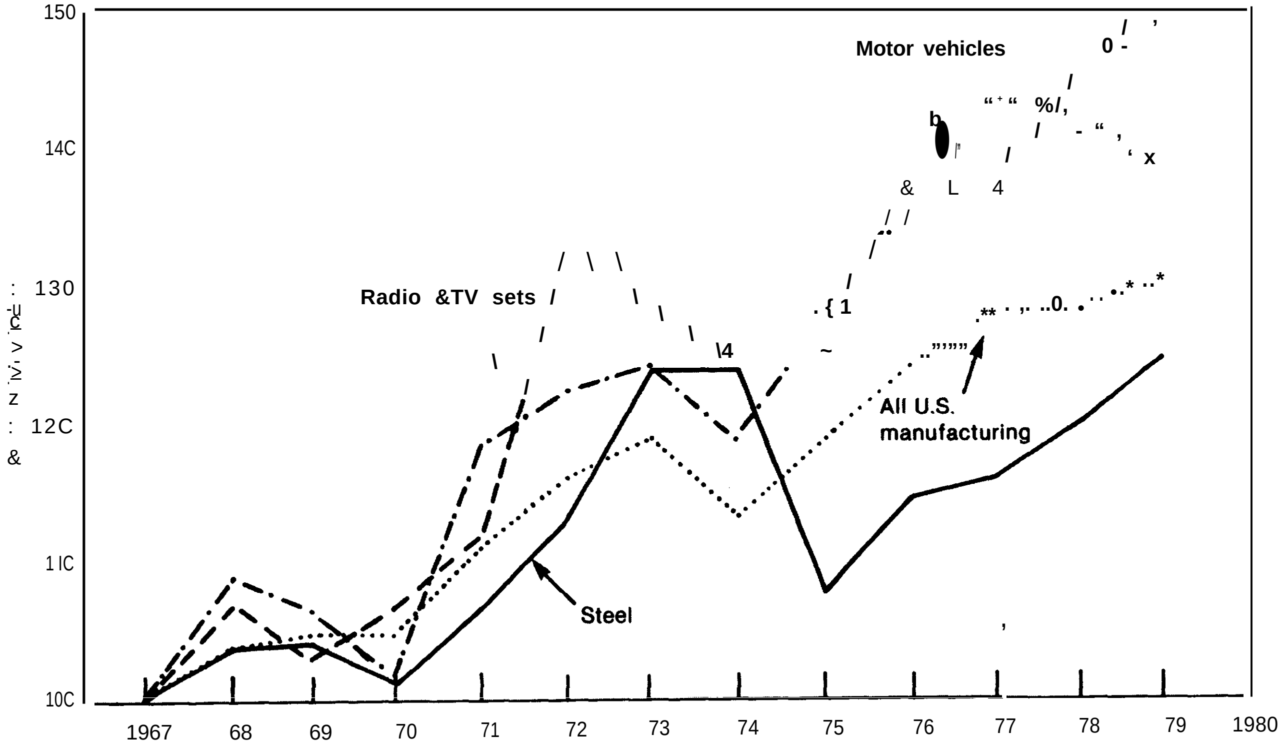
SOURCE Calculated from table 7

ficult to measure in any meaningful way because of the high rate of technical change. Falling prices for a given functional capability or given level of performance distort value-added figures and other cost/price indicators, In effect, price is not an adequate measure of the real value of a semiconductor device, because a dollar spent on a semiconductor this year buys much more than a few years ago. This is also true for computers and other products whose performance depends on semiconductors— in contrast to industries such as steel or automobiles.

The remaining sector, consumer electronics, is represented in table 7 and figure 3 by radios and TVs. On a value-added basis, this sector has approximately kept pace with other U.S. manufacturing industries. However, the BLS figures discussed below demonstrate that physical productivity has improved markedly for that portion of consumer electronics manufacturing still conducted in this country rather than offshore.

Figure 4 provides an alternative picture of changes in relative productivity—using the BLS index based on total physical output (rather than dollar value) per employee-hour. All employees are counted, not just production workers. Semiconductors and computers are omitted from this table, because physical

Figure 4.—BLS Productivity Indexes (physical output per hour—all employees, 1967 = 100)



SOURCE *F'roducf{vlty /ndexes for Se/ected /ndus/r~es* (Washington, D C Bureau of Labor Statlstlcs)

output has lit tle meaning for industries where a single chip or a single computer can now do what 10 did a few years ago.

In figure 4 the motor vehicle industry again exhibits substantially better than average productivity growth, while steel lags. The years 1973 and 1974 demonstrate how capacity utilization affects productivity in steel. Both were years of relatively high output; physical productivity was up about 10 percent as a result. In contrast, the high value--added productivity for 1974 (figure 3) was caused primarily by price increases averaging 27 percent (prices have no direct effect on the BLS index). Productivity increases in radio and TV have also been well above average. The results on a physical or per-unit basis (figure 4) are much more impressive than on a dollar-value basis (table 7 and figure 3) because intense competition has resulted in falling prices.

With the exception of the steel industry, there is little in the productivity data for these industries to suggest competitive difficulties stemming from an inability to keep pace with other domestic manufacturing sectors.

The next set of data—table 8—compares productivity trends in the United States and Japan, In this table, the situation of a particular sector relative to the rest of the domestic industry is the important comparison; average productivity growth in Japan compared to the United States is less meaningful, nor can industries in the two countries be compared on any simple basis (for one example, the sectors are not defined identically). Aggregate Japanese productivity remains well below that in the United States; the greater rate of advance shown in the table is at least in part attributable to the larger increments available to countries starting at low absolute levels of productivity. Nonethe-

Table 8.—Productivity Growth for the United States and Japan, 1970-79

	Productivity increase[a]	
Sector	United States	Japan
Average for all manufacturing . .	23%	90%
Steel	22	82
Motor vehicles	36	77
Radio and TV.	42	127

[a]Productivity in physical output per unit time – all employees

SOURCE United States —Productivity Indexes *for Selected Industries* (Washington, D C Bureau of Labor Statistics, Dec. 30, 1980)
Japan-Seisansei Tokei (Productivity Statistics) (Tokyo Seisansei Kenkynjo (Japan Productivity Center)), No 77. April-June 1977, No 88, January-March 1980

less, in particular industries—e.g., steel or automobiles—labor productivity in Japan may be close to or greater than in the United States; direct comparisons are difficult for a variety of reasons (see ch. 5 on automobiles),

In both countries, productivity in the steel industry rose at a slightly lower rate than for manufacturing as a whole. However, Japan's productivity in motor vehicles has also fallen relative to other Japanese industries, while in the United States automobiles show productivity growth which is considerably greater than the average. The significance of comparisons of one year to another (1979 to 1970) should not be exaggerated. In 1979, U.S. productivity dropped for both steel and motor vehicles compared to the previous year, largely because of recessionary effects—i.e., output. hence capacity utilization, decreased. In contrast, productivity y in Japan was greater for both industries in 1979 than in 1978. Nonetheless, table 8 would indicate, all else being equal, that automobile manufacturing in the United States should have enhanced competitiveness on a cost basis. All else has evidently not been equal.

Table 8 shows Japan's apparent improvement in consumer electronics to be very high. Even though American productivity in this sector has also increased more rapidly than the average for all manufacturing, the indicated productivity improvements in the Japanese consumer electronics industry have been much greater. These data go a long way towards explaining the strong price competition in consumer electronics over the past decade.

Wage Rate Trends

When firms or industries grant wage increases faster than their productivity increases, it is sometimes claimed that their international competitiveness must suffer. In fact, this is an overstatement, because inflation by itself does not impair competitive ability if exchange rates are free to adjust. On the other hand, if a particular industry agrees to wage increases exceeding not only its expected productivity improvements but also the average pay raises in other sectors of the economy, it does risk its competitive position. This is because the industry's costs, and presumably its output prices, would rise more rapidly than those elsewhere in the economy. Adjustments in the exchange rate to offset inflation would only partially offset these cost increases. Assuming that wage rates did not similarly outstrip productivity increases in competing industries abroad, the domestic industry could eventually confront more serious price competition both at home and overseas.

This section reviews wage trends in the three industries. Table 9 gives average wage data, excluding benefits, in current dollars for each industry. Better comparisons would be possible if fringe benefits could be included—particularly as they are much higher in some industries than in others. However, data on benefits are not available for all sectors, thus comparisons across sectors could not be made, Comparing the wage rate increases in table 9 with the BLS productivity index (productivity on a physical output basis) from the previous section shows that the average manufacturing wage in current dollars has increased at a rate greater than productivity for the last two decades. From

Table 9.—Average U.S. Wage Rates for Production Workers in Current Dollars per Hour'

Year	Steel	Electronics: Radio/TV receivers	Electronics: Semiconductors'	Electronics: Computers	Motor vehicles	All U.S. manufacturing
1960	$3.08	$2,06	$1.86	$2.60	$2.91	$2.26
1965	3.46	2.30	2.14	3.00	3.45	2.61
1970 ., . .	4.22	3.00	3.07	3.75	4.44	3.35
1975 .,	7.11	4.29	4.35	4.99	6.82	4,83
1976 . .	7.86	4.60	4.64	5.26	7.45	5.22
1977 ...	8.67	4,93	5.02	5.41	8.22	5.68
1978	9,70	5.49	5.44	5.57	8.97	6.17
1979	10.77	6.03	5.98	6.13	9.74	6.69

[a]Does not include benefits which have tended to rise faster than wages
[b]1960 and 1965 wage rates are for SIC category 365— Radio and Television Receiving Equipment, except Communication Types
[c]1960 and 1965 wage rates are for SIC categories 3674 and 3679—Semiconductors and Electronic Components N E C
[d]1960 and 1965 wage rates are for SIC category 357—Office, Computing, and Accounting Machines

SOURCES *All U.S. manufacturing—employment and Earnings 19097979* (Washington, D C Bureau of Labor Statistics June 1980)
Electronics: 1960-65— *Employment and Earnings, 19091975* (Washington, D C Bureau of Labor Stat{ stics, July 1976), 7970—U S *Census of Manufacturers 1972,* ***1975-79—*** *Employment and Earnings, 19091979* (Washington, D C Bureau of Labor Statistics June 1980)
Steel— *Annual Statistical Report* (Washington, D C American Iron and Steel Institute, June 1979)
Motor *vehicles—Ernp/oyrnenf and Earnings 19091979* (Washington, D C Bureau of Labor Stat{ stics, June 1980)

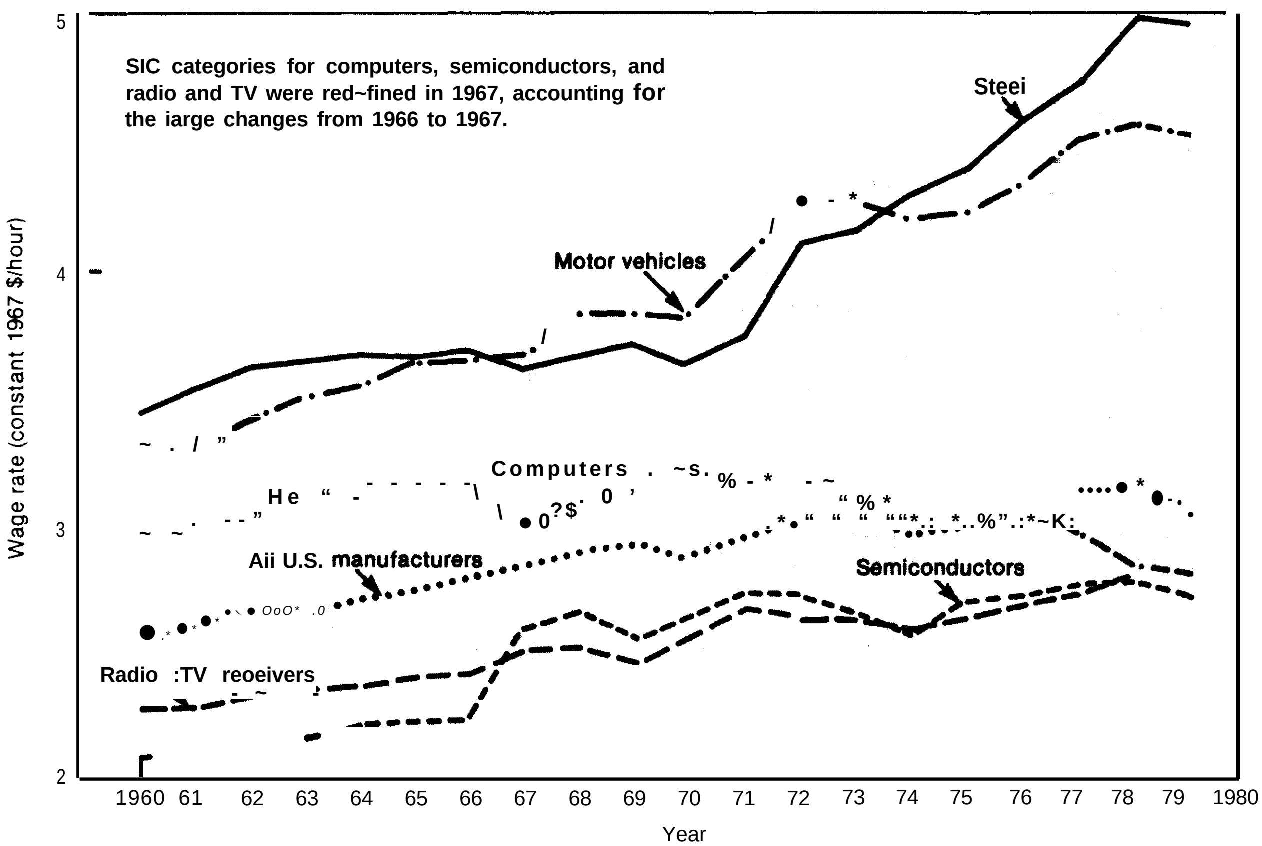
1970 to 1979, the average manufacturing wage doubled (table 9); average productivity in manufacturing increased only 23 percent (table 8).

Such behavior is typical of inflationary periods—in fact is one cause of inflation—but it is not necessarily a sign of declining international competitiveness. Assuming that differences in rates of general price inflation among the major industrialized countries are offset by shifts in exchange rates—often though not always true over long time periods— international competitiveness on a price basis need not be affected by inflation in any one country, A lo-percent price increase due to inflation should be balanced by a decline in the exchange rate, If, however, a particular industry grants wage increases which are greater than the inflation rate, and not counterbalanced by productivity increases, there could be a sharp impact on competitiveness. The question is: has this happened in any of these three industries? To examine this possibility, figure 5 plots wages converted to constant 1967 dollars.

Figure 5 shows— as did table 9—that both the steel and the automobile industry have paid higher wages than the average of all U.S. manufacturers, Much of this difference is due to the strong labor unions in these two industries. The work forces in both the steel and automobile sectors also tend to be older and to have achieved more seniority, hence higher wages, than in many other industries,

The trend in wages over time is more important than comparisons of one industry to another. For all U.S. manufacturing, constant dollar wages rose **6.6** percent during the period 1970 to 1979 while the BLS physical output productivity index rose 23 percent. Thus for U.S. manufacturing as a whole, productivity has increased faster than real wages (again recall that fringe benefits are excluded). For radio and TV receivers, real wages went up only 7,4 percent from 1970 to 1979, while productivity rose 42 percent. On this basis, the radio and TV sector should exhibit improved competitiveness since its productivity has increased much faster than the average in manufacturing, and wages at about the same rate (that its competitiveness has declined instead of improving indicates that other factors have had an overriding influence, as discussed elsewhere). On the other hand, for the steel industry, constant dollar wages rose by 36 percent and productivity by only 22 percent for the 1970-79 period, Thus, the wage component of production costs for steel rose considerably faster than productivity for this period— in marked contrast to U.S. manufacturing in the aggregate. This is one reason for the deterioration in competitiveness of the American steel industry. The relatively slow rise in productivity is associated with an in-

Figure 5.—Average U.S. Wage Rates for Production Workers in Constant 1967 Dollars per Hour



SOURCES All U.S. *manufacturing-Employment and Earnings, 1909-1979* (Washington, D C Bureau of Labor Statistics, June 1980)
Electronics: 1960.65 -Employment and Earnings, 1909.1975 (Washington, D C Bureau of Labor Statistics, July 1976), 1970—U. S *Census of Manufacturers, 1972; 1975 -79—Employment* and *Earnings, 1909-1979* (Washington, D C Bureau of Labor Statistics, June 1980).
Steel–Annual Statistical Report (Washington, D C American Iron and Steel Institute, June 1979)
Motor vehicles—Employment and Earnings, 1909.1979 (Washington, D.C. Bureau of Labor Statistics, June 1980)

creasingly obsolescent capital plant, among other factors.

As in steel, auto industry wage levels have been consistently above the all-industry average (figure 5). There the similarity ends—mostly because the automobile sector has experienced productivity gains twice those in steel (figure 4). Thus, the effects of higher wages have been at least partially counterbalanced by improvements in output per manhour.

Except for consumer electronics, where real wages grew far slower than productivity, there is little useful data for electronics—again because rapid technological change makes labor productivity figures of little meaning. Those data that are available (e.g., value-added per worker-hour) suggest significant productivity gains in recent years compared to the very modest upward movement in constant-dollar wages (real wages have actually declined in the computer industry).

Finally, the Japanese experience might again be mentioned. Between 1973 and 1979, average real wages in Japan increased about 10 percent. During the same period, labor productivity increased by over 35 percent. This suggests that in many Japanese industries, productivity has been increasing faster than wages—with beneficial effects on competitiveness.

Other Measures of Competitiveness

The data reviewed in the preceding sections provide a picture of international competitiveness from a comparative advantage or relative cost standpoint. As discussed in appendix A, there are other possible indicators of competitiveness, often of rather limited significance. Together these also suggest a relative decline of U.S. manufacturing industries compared with major international competitors, Several of these are reviewed below."

One of the measures examined in the "Productivity" section was physical output per employee-hour (the BLS index), International comparisons based on the growth rate of this index show that manufacturing productivity in the United States has grown far less rapidly in the postwar years than in many other industrialized nations—table 10. Note that although aggregate productivity growth in the United States has slowed in recent years, manufacturing productivity increased at about the same rate during the **1970's** as in earlier years. Growth rates for all the countries tended to slow over the past decade, one reason being rapidly rising energy prices, which have affected Western European nations and Japan more than the United States.

Figure **6** demonstrates the long-term effects of slow productivity growth in the United States compared to other industrialized countries. Here each nation's real gross domestic product (GDP) per employee is compared to the level in the United States, indexed as 100 (i.e., GDP per employee as a percentage of the U.S. figure). "These percentages are based on output figures originally expressed in different currencies; when exchange rates shift, and when the shifts are not directly related to differential inflation rates, some distortion is likely. Similarly when monetary systems move from fixed to flexible exchange rates, there can be short-term distortions. Thus, the trends over time in figure 6 are more meaningful than year-to-year variations.

The data in figure 6 show that output per employee in Japan is still only two-thirds that in the United States; however, the Japanese economy has grown at roughly four times the rate of the U.S. economy since 1950. In contrast, the United Kingdom has grown at almost the same rate as the United States. France and West Germany have doubled their outputs compared to the United States (but recall that it is always easier to catch up). To the extent that a relative decline in GDP is a gross measure of loss in competitiveness, the United States is losing with respect to its major competitors. But in comparison with Japan, all countries have been declining, as also implied by the productivity figures in table 10. At the same time, the United States retains its absolute lead among the countries included in figure 6.

There has also been considerable concern about the relative state of American technol-

'M. E. Mogee, Technology and Trade: Some Indicators of the State of U.S. Industrial Innovation (Washington, D, C.: Subcommittee on Trade, Committee on Ways and Means, U.S. House of Representatives, Apr. 21, 1980].

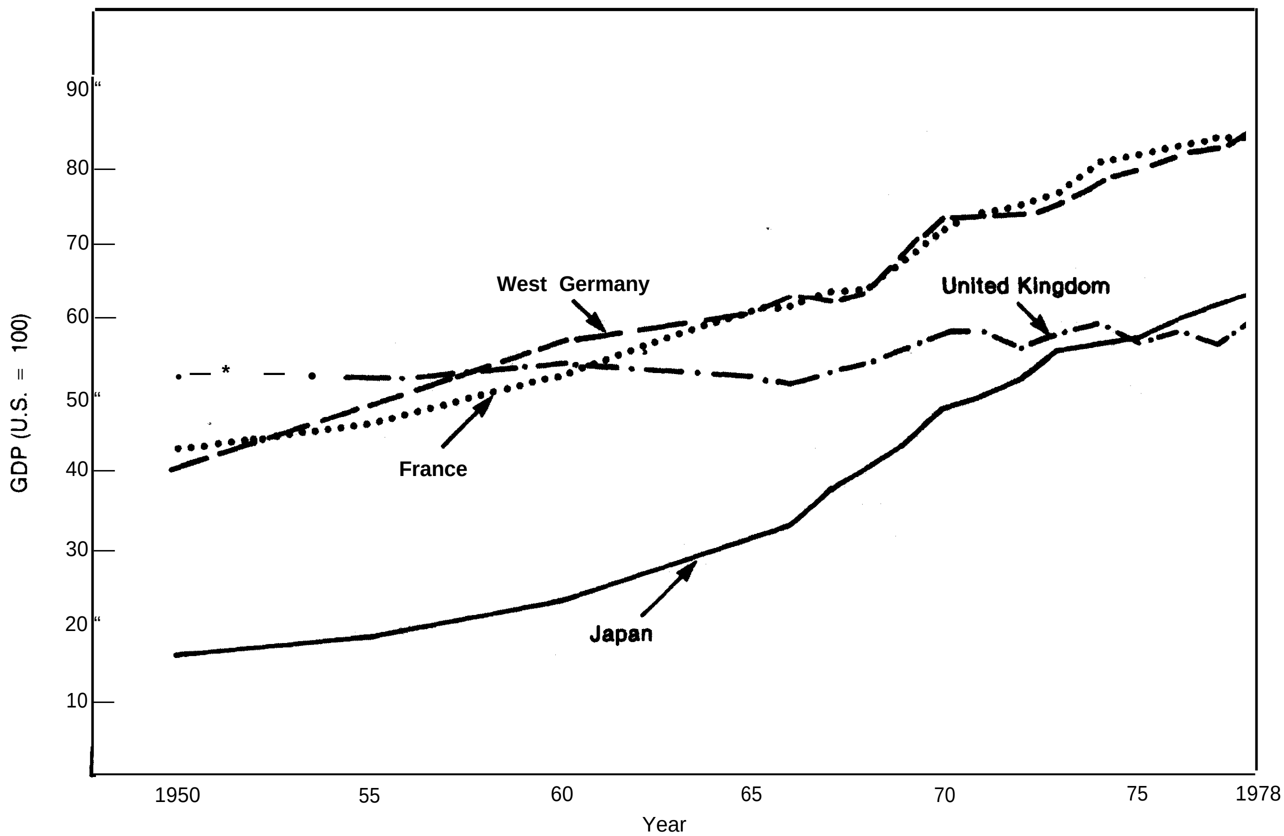
'GDP consists of total goods and services produced within an economy. The primary difference between GDP and GNP is that GNP also includes the net of income of overseas investment overseas brought back to the economy of interest and of foreign earnings that leave that economy,

Table 10.—Average Annual Rates of Productivity Growth in Manufacturing (physical output per hour, all employees)

Time period	United States	Japan	France	West Germany	United Kingdom
1950-70	2.4 %.	10.1 %	5.2%	5.8%	"2,9"10
1970 -79..., ...	2.3	7.4	5.0	5.3	2.1

SOURCE Output per Hour, Hourly Compensation, and Unit Labor Costs In Manufacturing, Eleven Countries 19501979 (Washington, D C Bureau of Labor Statistics, December 1980)

Figure 6.—Real Gross Domestic Product (GDP) per Employed Person Relative to the United States as 100



SOURCE: M. E. Mogee, Technology *and Trade Some Indicators of the State of U S Industrial Innovation* (Washington, D C Subcommittee on Trade, Committee on Ways and Means, U S. House of Representatives, Apr. 21, 1980), p 25 From BLS data

ogy. Leaving aside national defense, this appears to have two distinct thrusts. First, technological advance is one source of product innovations. New and innovative products—resulting in part from R&D—have been a mainstay in U.S. exports of manufactured goods as well as in the expansion of American firms abroad. Now some observers see the Nation's strength in innovation waning. Second, new process technology can be an important means of lowering costs and improving productivity y.

Innovations of the more dramatic type often lead to rapidly expanding sales, large profits, and sometimes to entirely new industries. Early innovators have opportunities for gaining market share and strong competitive positions. Postwar examples include xerography, the transistor, and Polaroid photography. Process innovations may not attract as much public attention but can be equally important— continuous casting of steel, the float glass process, robots for spray painting automobiles.

It is difficult to compare the state of American technology to that of other nations except on an item-by-item basis. R&D expenditures can be used, but are a measure of the inputs to activities directed at new products and processes, not the outputs. In absolute expenditures on R&D, the United States leads the Western world by a large margin, as table 11 illustrates. Not only does this country spend more in absolute terms on R&D, but the United States spends more as a percent of GDP than its major rivals. The United States

Table 11.—R&D Expenditures (all sources) as a Percentage of Gross Domestic Product

	1967	1975
United States		
Total	**2.9%**	**2.3%**
Military	1,12	0.64
Japan		
Total	1.3	1.7
Military	0.02	0.01
France		
Total	2.2	1.8
Military	0.55	0.35
West Germany		
Total	1.7	2.1
Military	0.21	0.14
United Kingdom		
Total	2.3	2.1
Military	0.61	0.62

SOURCE: *Technical Change and Economic* Policy(Paris Organization for Economic Cooperation and Development, 1980) p 30

does spend less as a percentage of GDP than in the past, but total R&D expenditures in constant dollars have not changed much since 1966.[6] Table 11 also shows that U.S. expenditures for military R&D are greater—both in absolute terms and as a percent of GDP—than in other countries, Although the proportion of U.S. R&D effort devoted to defense-related activities has been going down, it is still large, While some military R&D gives results useful to commercial industries, not all military technologies contribute to competitive strength.

Although R&D spending can be disaggregate in various ways, the relative contributions to competitive ability of basic research, applied research, and development (the latter receiving by far the largest expenditures) cannot be readily disentangled. However, some observers believe that the United States is now overemphasizing short-term R&D with immediate payoffs at the expense of longer term work aimed at maintaining the science and technology base.

As table 12 shows, in the United States only a small proportion of Government-funded R&D goes towards the advancement of knowledge (i. e.. both basic and applied R&D, but not directed at specific products or processes). The table indicates that the two strongest rivals of the United States in high-technology industries-Japan and West Germany—devote more than half of all government-funded R&D to the advancement of knowledge, while the U.S. spends less than 5 percent on this category. Of course, Japan in particular spends little on defense.

In most nations the portion of total R&D funded by industry which goes toward basic research runs between 3 and 10 percent, [7] While industries in both Japan and West Germany spend a greater fraction of their own R&D funds on basic research than in the United States, the differences are a few percentage points—not nearly as striking as the divergence in government funding shown by table 12.

To summarize:[8]

1. Total U.S. expenditures on industrial (including military) R&D have been rela-

[6] Mogee, op. cit., p. 8.

[7] *Technological Change* and Economic *Policy* (Paris: Organization for Economic Cooperation and Development, 1980), p. 36.

[8] Mogee, op. cit.; also *Technological Change and Economic* Policy. op. cit.

Table 12.—Percentage Allocation of Government-Funded R&D by Objectives, 1975

	Advancement of knowledge	Military	Civilian industry[a]	Other[b]
United States	**3.9%**	**49.8%**	**21.3%**	25.0%
Japan	55.8	2.2	20.0	22.0
France	25.3	29.5	25.8	19.4
West Germany	51,0	11.1	22.3	15.6
United Kingdom	21.4	48,9	26.8	2.9

[a] Civilian industry includes space
[b] Includes health, agriculture, and environmental Protection

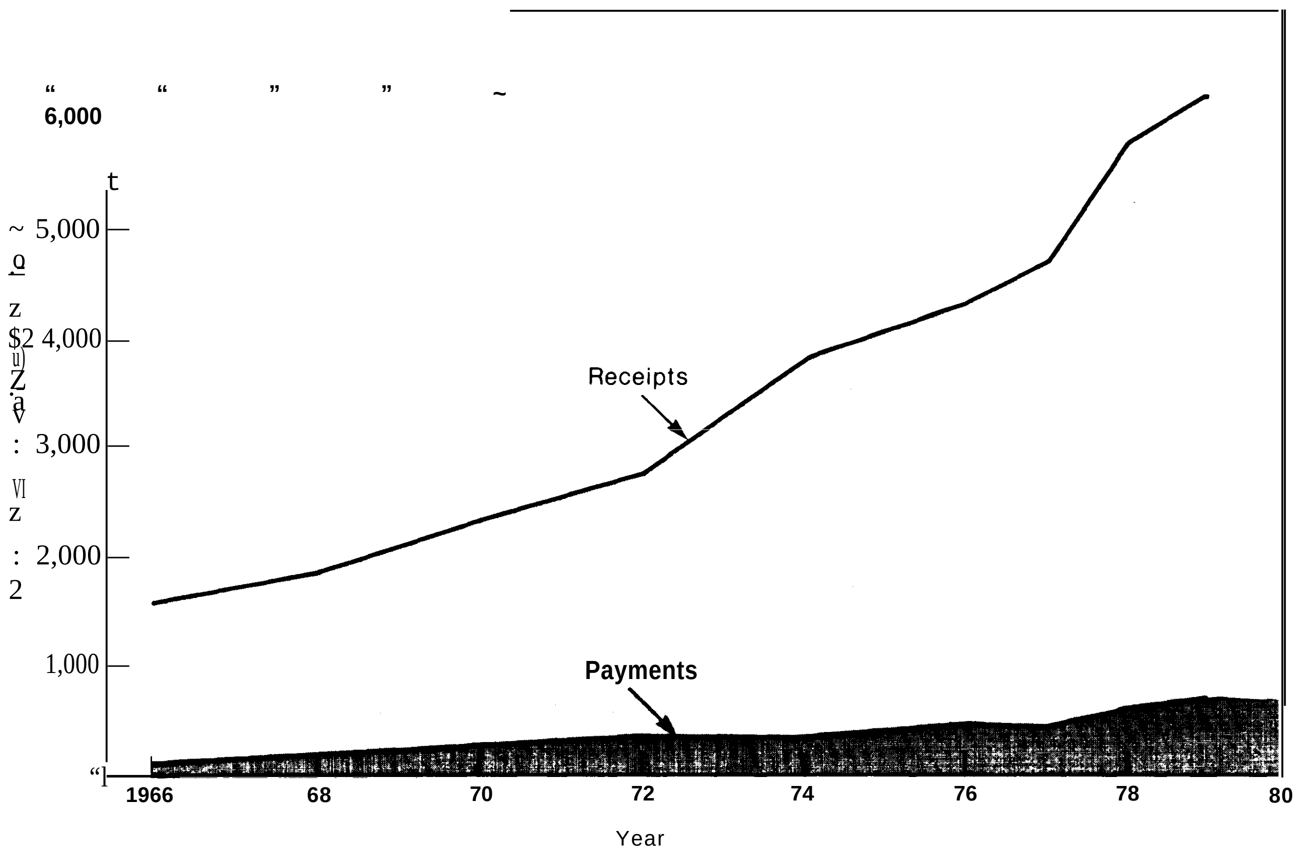
SOURCE *Technical Change and Economic Policy* (Paris Organization for Economic Cooperation and Development 1980) p 37 tively stable in constant dollars for about 15 years. Private sector funding has been rising at an average annual rate of nearly 5 percent, while Federal Government expenditures have been falling since the late 1960's with only a slight recovery in the past few years.

2. Total R&D expenditures have been a declining portion of U.S. GDP for 15 years.
3. Other nations—e.g., West Germany and Japan—have been increasing R&D expenditures both absolutely and as a percentage of GDP. Japan has recently set a long-term goal of spending 3 percent of its GDP on R&D. But in absolute terms, R&D expenditures in the United States remain much greater than in any other Western country.

These trends do not prove that relative declines in R&D spending have harmed U.S. competitiveness. Other countries have increased their technological capabilities through a variety of means—only one of which is R&D (technology transfers—e. g., from the United States—are one alternative). Nonetheless the coincidence of relative declines in funding for R&D and in industrial competitiveness is disturbing.

On the other hand, the United States maintains a large and growing surplus of earnings from licensing fees and royalties for technology. These data are shown in figure 7. Many receipts and expenditures simply represent transactions with foreign subsidiaries of U.S. firms, Moreover, payments are often compen-

Figure 7.—Royalty and License Payments and Receipts of U.S. Firms



SOURCE A J DiLullo, U S International Transactions, First Quarter 1980," *Survey of* Current *Business, VOl* 60, June 1980, PP 32-33 sation for technology developed in earlier periods. RCA, for example, still receives roughly $50 million per year from Japanese firms for color TV technology mostly dating from the 1960' s." Still, the balance of transactions in fees and royalties is one of the few measures specifically related to outputs rather than inputs of R&D and other activities directed a t innovation. No deterioration in this balance is thus far evident. of course, it is precisely the transfer of U.S. technology to foreign firms [represented by the receipts in figure 7) which some observers blame for slackening U.S. competitiveness.

'R. A. Joseph. " Automation Helps RCA and zenith keep Color-TV Leadership in face of Imports, wall, street Journal. May 5. 1981. p.56.

Summary and Conclusions

The measures of competitiveness examined in this chapter have been rather general in nature— e.g., productivity across an entire industrial sector. Many other factors are also important for competitive ability—for instance, quality of management or the effects of public policies. Factors of the latter type, some of which are covered in later chapters, often influence measures such as productivity.

Broad economic parameters such as productivity, wage levels, and aggregate R&D expenditures are certainly important for international competitiveness; more rapid economic growth would help many American industries maintain their competitive positions. Yet the fates of specific firms and industries are only loosely related to aggregate economic growth. In the same way, the overall health of the science and technology enterprise affects the competitiveness of many industries —often in unanticipated ways. It is difficult to link events in any one industry to science and technology in general. Nonetheless, high-technology industries, notably computers, are large exporters and have also shown rapid productivity advance; by any measure the computer industry appears competitive. The same is true for semiconductors, although here exports and imports are nearly in balance. The competitiveness of both sectors has been helped by wage levels that are low compared to automobiles and steel, However, I he consumer electronics industry— also characterized by low wages—is, by the indicators of international trade, the least competitive. Possible explanations for the difficulties experienced by this sector are examined in chapter 5.

Import penetration is not a new phenomenon in steel and automobiles, although imports have been steadily increasing, particularly in autos. The present competitive problems in the U.S. automobile industry have causes which largely evade the measures examined in this chapter.

The steel industry has been harmed by slow productivity growth and high wage levels; low profits have made it difficult to modernize, although new plant and equipment could lower costs and improve productivity. And, *despite* the relatively slow rate of productivity growth in steel, the U.S. industry is on average competitive in its absolute labor productivity with Japan. At comparable rates of capacity utilization, the Japanese industry would be superior; but since U.S. steelmaker have in recent years been operating closer to full capacity, their absolute productivity has been comparable to that achieved in Japanese mills, In other sectors, productivity increases compare favorably with the rest of U.S. manufacturing; lagging productivity growth cannot explain the apparent slackening of competitiveness in sectors such as consumer electronics or automobiles.